



PROCEEDINGS BOURNEMOUTH
NATURAL SCIENCE SOCIETY!

for Vol. 6

See ANNUAL REPORT

1913-1914.

Bind this slip in
front of Vol 7

PROCEEDINGS

OF THE

Bournemouth
Natural Science
Society.

—
VOL. VII.
—

SESSION 1914-1915.



S. B.

PROCEEDINGS of the

Bournemouth Natural Science Society.



: : VOL. VII. : :
SESSION 1914-15.

PUBLISHED BY THE SOCIETY AT ITS ROOM,
THE MUNICIPAL COLLEGE, BOURNEMOUTH, 1916.

BOURNEMOUTH :

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Introductory Note.

THE BOURNEMOUTH NATURAL SCIENCE SOCIETY was founded in 1903, being the successor to an older society which was formed in 1883 and dissolved in 1897. Its objects are declared by the second of its rules to be "the promotion of the study of Science in all its branches, by means of Lectures, Field Meetings, the Reading and Discussion of Papers, and the formation of Sections of its members devoted to any particular branch of the Society's work."

The Sections at present working are as follows:—**Archæological and Historical, Botanical, Entomological, Geographical, Geological, Microscopical and Zoological, Photographical, and Physical.**

During the WINTER SESSION, from October to April, GENERAL and SECTIONAL MEETINGS are held. TWO GENERAL MEETINGS are usually held in each month, comprising Lectures and Demonstrations on various subjects of scientific interest, illustrated by lantern slides, diagrams, or specimens.

SECTIONAL MEETINGS.—Each Section usually holds a meeting once a month. At these meetings the papers read are more specialized and technical than at the General Meetings.

In previous years meetings have been held at 4.30 p.m., but, in consequence of the present darkened state of our streets, the time of meeting, until further notice, will usually be 3 p.m.

GENERAL MEETINGS, as a rule, are held at Trinity Hall, Lorne Park, and SECTIONAL MEETINGS at the Society's Room in the Municipal College.

Throughout the SUMMER SESSION, GENERAL EXCURSIONS to places of interest in the neighbourhood are arranged once or twice in each month. SECTIONAL EXCURSIONS are usually arranged weekly under the various sections.

The management of the Society is vested in a Council, which is elected at the Annual General Meeting, held in October.

The Members are elected by the Council, and pay an annual subscription of Ten Shillings for full membership (admitting to all meetings and excursions for the year). Visitors to Bournemouth are permitted to join for the Winter or Summer Sessions on payment of seven shillings and sixpence, if approved by the Council.

The Society is endeavouring to lay the foundations of a MUSEUM by acquiring collections of archæological, botanical, geological, zoological, and other specimens of scientific interest. A good beginning has already been made in several directions, especially by the acquisition of the valuable Dent Collection of Barton Fossils. Particulars as to the objects and hopes of the Society in this direction will be found in the special article contributed to Volume V. by the President.

A MONTHLY NOTICE, giving full details of all meetings, etc., is posted to every member before the beginning of each month, and a volume of Proceedings is published every year.

Application Forms for Membership, and further particulars, can be obtained from the

HON. SECRETARY,

Bournemouth Natural Science Society,

Municipal College,

Bournemouth.

Bournemouth Natural Science Society.

OFFICERS AND COUNCIL FOR 1915—1916.

President:

SIR DANIEL MORRIS. K.C.M.G., J.P., M.A., D.Sc., D.C.L., F.L.S.

Vice-Presidents:

G. E. J. CRALLAN. M.A., M.B., M.R.C.S.	REV. E. F. LINTON, M.A., F.L.S.
*GEO. G. HAMILTON, F.R.C.S., F.R.H.S.	DR. W. T. ORD, F.G.S.
S. McCALMONT HILL, D.C.L.	DR. A. RANSOME, M.A., F.R.S.
JAS. E. LIDDIARD, F.R.G.S., M.N.G.S. of U.S.A.	MISS C. AGNES ROOPER.
M.J.S.	DR. J. ROBERTS THOMSON, J.P.

Chairman of Council:

*GEO. G. HAMILTON, M.B., F.R.C.S., F.R.H.S.

Deputy-Chairman of Council:

HENRY BA KHOUSE, F.R.H.S.

Council:

THE OFFICERS (ex-officio) and

HENRY BACKHOUSE, F.R.H.S.	H. LE JEUNE.
JAS. DRUITT, J.P.	CLAUDE LYON.
ROB. FURLONG, C.B., J.P., M.A.	SIR DANIEL MORRIS, K.C.M.G., J.P.
J. M. FRENCH.	F. GEO. PENROSE, M.D., F.R.C.P., F.Z.S.
*GEO. G. HAMILTON, M.B., F.R.C.S., F.R.H.S.	J. H. SCOTT, M.E., M.I.M.C.E.
S. McCALMONT HILL, D.C.L.	R. V. SHERRING, F.L.S.

Chairmen of Sections:

Archæological and Historical: Rev. H. SHAEN SOLLY, M.A.
 Botanical: MISS C. AGNES ROOPER.
 Entomological: F. GEO. PENROSE, M.D., F.R.C.P., F.Z.S.
 †Geographical: GEO. DE CASTRO, M.R.C.S., ENG.
 Geological: W. MUNN RANKIN, M.Sc., B.Sc.
 Photographical: R. Y. BANKS.
 Physical: HUBERT PAINTER, B.Sc., F.C.S.
 Zoological and Microscopical: T. B. GOODALL, F.R.C.V.S., F.L.S.

Hon. Treasurer:

GEO. BRUMELL, A.R.I.B.A.

Secretaries:

Joint Hon. Secretaries: { R. A. DE PAIVA, San Remo, Carysfort Road, Bournemouth.
 THOS. CAPPER, M.A., B.Sc., Ropley, Stirling Road,
 Bournemouth.

Assistant Secretary: J. F. SPENCER, Glenthorne, Richmond Park Road,
 Bournemouth.

Hon. Librarian:

HY. J. ELLIS.

Hon. Editor:

HUBERT PAINTER, B.Sc., F.C.S.

Hon. Auditors:

E. BICKER.

E. M. BARLOW, B.Sc., F.R.A.S.

Bankers:

NATIONAL PROVINCIAL BANK OF ENGLAND, BOURNEMOUTH.

PAST PRESIDENTS:

1903-4	..	..	J. E. BEALE (Mayor of Bournemouth).
1904-5—1905-6	..	..	G. E. J. CRALLAN, M.A., M.B., M.R.C.S.
1906—1907	..	..	H. J. WADDINGTON, F.L.S.
1907-8—1908-9	..	..	DR. A. RANSOME, M.A., F.R.S.
1909-10	..	..	DR. A. SMITH WOODWARD, LL.D., F.R.S., F.L.S., F.G.S.
1910-11	..	..	DR. DUKINFIELD H. SCOTT, M.A., LL.D., F.R.S., F.G.S.
1911-12—1912-13	..	..	SIR E. RAY LANKASTER, K.C.B., M.A., LL.D., F.R.S., F.L.S.
1913-14—1914-15	..	..	SIR DANIEL MORRIS, K.C.M.G., J.P., M.A., D.Sc., D.C.L., F.L.S.

* Now deceased. See obituary notice in this volume.

† Retired. Succeeded by Claude Lyon.

Annual Meeting, 1915.

THE Annual Meeting for 1914-15 was held in the Society's Room at the Municipal College on Saturday, October 30th, at 4.30 p.m. Sir Daniel Morris, K.C.M.G., J.P., President of the Society, was in the chair.

In the absence of the Hon. Treasurer, due to ill-health, the Treasurer's audited annual statement of accounts was read by the Hon. Secretary. It showed receipts £318 16s. 11d. and payments of £219 4s., leaving a balance of £99 12s. 11d. The Hon. Secretary read the Council's Report, which recorded a year of continued activity. It referred to the visit of the British Association to Bournemouth in 1917 at the invitation of the Mayor and Corporation. Sir Daniel Morris attended as Delegate from the Society to the meeting at Manchester, Dr. S. McCalmont Hill, one of our Vice-Presidents, joining with him to strengthen our representation.

The Chairmen of Sections presented their reports of the work done in their respective Sections.

Sir Daniel Morris then left the chair, which was taken by Dr. McCalmont Hill. Dr. Moorhead, referring in eulogistic terms to the valuable work done by Sir Daniel for the past two years, proposed his re-election as President for 1915-16. The Rev. W. H. Windle Cooper having seconded in a similar strain, the proposition was carried unanimously. Sir Daniel, in reply, thanked the meeting for the honour conferred upon him and promised to continue his efforts to further the interests of the Society.

The officers who had served during the year were then re-elected and also the members of Council, with the exception of Mr. R. Y. Banks, whose appointment as Chairman of the Photographic Section caused a vacancy, which the President proposed should be filled by Dr. Francis George Penrose, M.D., F.R.C.P., F.Z.S. This was seconded by Mr. George de Castro and carried unanimously.

Mr. E. Bicker and Mr. E. W. Barlow were elected Hon. Auditors for the year, and votes of thanks were passed to the Auditors of last year, and to the President for past services.

Sir Daniel Morris announced that he would give his Presidential Address on Saturday, November 13th. The subject would be a review of some of the more notable and interesting trees in the neighbourhood.

Summary of Cash Account for year ending 30th September, 1915.

RECEIPTS.

	Amounts for previous year.		
	£ s. d.	£ s. d.	£ s. d.
Balance at Bank on Ist. Oct., 1914	55 17 2	76 1 4	
Members' Subscriptions ...	191 12 6	232 2 6	
Subscriptions in Advance, 1915-16	2 0 0	3 0 0	
Sale of Volumes of Proceedings ...	2 0 6	0 8 0	
Sale of "Natural History of Bourne- mouth" ...	3 15 3	0 0 0	
Surplus from Excursions	8 6 9	3 11 11	
Proceeds of Mr. Hankinson's Lec- ture for Benefit of Belgian Refugees ...	55 0 9	0 0 0	
Sundry Receipts	0 4 0	5 13 7	

£318 16 11

We have examined the foregoing Account with the Vouchers for Receipts and Payments and have found the same correct.

15th October, 1915.

EDWARD BICKER, }
HENRY BACKHOUSE, } Auditors.

PAYMENTS.

	Amounts for previous year.		
	£ s. d.	£ s. d.	£ s. d.
Rent of Room, Municipal College...	25 0 0	25 0 0	
Hire of Trinity Hall ...	5 0 0	6 17 6	
Salary of Assistant Secretary ...	10 0 0	10 0 0	
Printing and Stationery ...	21 12 8	23 1 9	
Annual Report, replacing Vol. VI. of Proceedings ...	4 4 0	55 16 2	
Furniture and Upkeep of Rooms ...	2 1 6	53 18 6	
Expenses of Lectures ...	17 5 8	26 3 7	
Postage ...	17 11 10	19 15 9	
Subscriptions to other Societies ...	3 18 0	3 18 0	
Insurance ...	1 9 7	1 4 8	
In Connection with Collections of Specimens and Records ...	18 13 2	16 13 0	
Books ...	2 6 8	10 12 0	
Balance of Cost of Natural History Proceeds of Mr. Hankinson's Lec- ture:	32 13 7	0 0 0	
Local Belgian Fund ...	27 10 5	0 0 0	
Central Belgian Fund ...	27 10 4	0 0 0	
Sundries ...	2 6 7	1 14 3	
Balance at Bank	<u>£219 4 0</u>	<u>99 12 11</u>	
	<u>£318 16 11</u>		

Council's Report

for the Year ending September 30th, 1915.

IN presenting the Twelfth Annual Report the Council has the pleasure to record another year of continued activity, though, in consequence of the war, in common with most other Societies, the membership has to some extent been reduced.

The number of members on the 30th September was 408, against 516 on the same date last year.

The number on 30th October (Annual Meeting) was 393, against 498 on the same date last year.

During the year general and other meetings were held as follows:—

The Annual Meeting.

The Presidential Address.

10 General Lectures.

30 Sectional Lectures.

9 Botanical Meetings for the Microscopical Study of Algæ.

4 General Excursions.

17 Sectional Excursions.

making a total of 72 meetings and excursions as compared with 70 during the previous year.

The General Lectures were as follows:—

1914.

Nov. 14.—The Presidential Address, by Sir Daniel Morris, K.C.M.G., etc.

Dec. 5.—“The Excavations at Hengistbury Head,” by Mr. Wm. Dale, F.S.A.

Dec. 12.—“Petrograd, Moscow and Nijni Novgorod,” by Rev. W. H. Windle Cooper, M.A., F.R.G.S.
1915.

Jan. 16.—“Protective Colouration in Birds,” by Dr. Francis Geo. Penrose, M.D., F.R.C.P., F.Z.S.

Jan. 30.—“Ireland from Within,” by Mr. Jos. Neale, B.A.

Feb. 13.—“The Great Stone Crosses in Northumbria,” by Mr. W. Franklin Rawnsley, M.A., J.P.

Feb. 27.—“Evolution in the Past,” by Mr. Hy. R. Knipe, F.L.S.

Mar. 13.—“Mechanical Structures in Plants, exhibiting Engineering Processes,” by Rev. Professor Geo. Henslow, M.A., F.L.S., F.G.S.

Mar. 20.—“The Camera as Historian,” by Mr. L. Stanley Jast.

April 14.—“Giotto's Bell Tower in Florence,” by Rev. Edgar J. Fripp, B.A.

April 24.—“Lime in the Service of Man: An Account of some of the Applications of Calcium Compounds in the Arts and Industries,” by Mr. Hubert Painter, B.Sc., F.C.S.

All but one were illustrated by Lantern Slides.

The General Excursions, with their conductors in each case, were as follows:—

1915.

May 29.—Highcliffe Castle, by Sir Daniel Morris, K.C.M.G.

- June 17.—Cranborne Manor, by the Rev. Hy. Shaen Solly, M.A.
 July 27.—Crichel Park and Gardens, by Mr. Hy. Backhouse, F.R.H.S.
 Sept. 2.—Wimborne St. Giles and Knowlton, by Rev. Hy. Shaen Solly, M.A.

The Lectures in the various Sections were as follows:—

In the Archæological and Historical Section.

1914.
 Nov. 23.—“Peace and War on Cranborne Chase in Pre-historic Times,” by Mr. Heywood Sumner, F.R.S.
 Dec. 3.—“Early Man in Dorset,” by Rev. Hy. Shaen Solly, M.A.
 1915.
 Jan. 19.—“Historical Autographs in the British Museum,” by Mr. Hy. J. Ellis.
 Feb. 25.—“A Visit to the Great Temple of Karnak,” by Mr. Claude Lyon.
 Mar. 27.—“The Greeks in Britain,” by Mr. Edwin W. Fletcher, F.S.A.

In the Botanical Section.

1914.
 Nov. 17.—“A Resumé of the Year’s Work,” by Miss C. Agnes Rooper.
 Dec. 8.—“Some Isle of Purbeck Plants, Part I,” by Mr. C. B. Green.
 1915.
 Jan. 21.—“Azolla and Pilularia,” by Mr. W. Munn Rankin, M.Sc., B.Sc.
 Feb. 4.—“Galls in Flowering Plants and Trees,” by Mr. Geo. G. Hamilton, F.R.C.S., F.R.H.S.
 Mar. 4.—“Some Isle of Purbeck Plants, Part II,” by Mr. C. B. Green.
 Mar. 25.—“Lime as an Agent in the Nutrition, Protection and Distribution of Plants,” by Sir Daniel Morris, K.C.M.G.

There were also nine Meetings for the Microscopical Study of Algæ on Nov. 5th and 19th, Dec. 3rd, Jan. 7th and 21st, Feb. 4th and 18th, March 4th and 18th.

In the Entomological Section.

1914.
 Dec. 11.—An Address, by Mr. Rd. Beck, F.E.S.
 1915.
 Jan. 14.—“The Significance and possible Origin of Colour pattern of the Puss Moth Caterpillar,” by Mr. Jos. Neale, B.A.
 Feb. 11.—An Exhibition of Insects by Members.
 Mar. 11.—An Exhibition of Insects by Members.

In the Geographical Section.

1914.
 Nov. 21.—“The Extra-European Possessions of the German Empire,” by Mr. Geo. de Castro, M.R.C.S.
 1915.
 Feb. 20.—“Calcium and its Compounds from a Geographical Standpoint,” by Mr. W. J. Woodhouse, A.C.P.

In the Geological Section.

1914.
 Dec. 10.—“The Story of River Action,” by Mr. W. Munn Rankin, M.Sc., B.Sc.
 1915.
 Jan. 27.—“The Forerunners of the Flowering Plants,” by Dr. Dukinfield H. Scott, M.A., LL.D., F.L.S., F.G.S.
 Feb. 18.—“The Geology of the Local Chalk,” by Mr. W. Munn Rankin, M.Sc., B.Sc.

- Feb. 23.—“Ancient Rivers of Bournemouth,” by Mr. Clement Reid, F.R.S., F.G.S.
 Mar. 17.—“Lakes in Geography and Geology,” by Mr. W. Munn Rankin, M.Sc., B.Sc.

In the Photographic and Record Section.

1914.
 Dec. 9.—“Some Notes on Copying and the Making of Slides from Pictures, Diagrams, etc.,” by Mr. E. Dodshon.
 1915.
 Feb. 10.—“Natural Colour Photography, Illustrating the Paget Duplicating Process,” by Mr. R. Y. Banks.

In the Physical Section.

1914.
 Nov. 26.—Notes on Recent Advances in Physical Science,” by Mr. Hubert Painter, B.Sc., F.C.S.
 1915.
 Jan. 9.—“Lime and Other Compounds of Calcium considered from the Standpoint of Chemistry and Physics,” by Mr. Hubert Painter, B.Sc., F.C.S.
 Jan. 28.—“Some Interesting Problems in Astronomy,” by Mr. Claude Lyon.

In the Zoological and Microscopical Section.

1914.
 Nov. 19.—Various Theories of Heredity,” by Mr. W. Munn Rankin, M.Sc., B.Sc.
 1915.
 Jan. 7.—“The Cell and Heredity,” by Mr. W. Munn Rankin, M.Sc., B.Sc.
 March 6.—“Woodlice,” by Mr. W. Omer Cooper.

The Excursions of the various Sections, and their conductors were:—

Archæological Section.

1915.
 May 11.—Hambleton Hill, by Rev. Hy. Shaen Solly, M.A.
 July 13.—Almer, Winterbourne Tomson, Woodbury Hill and Bere Regis, by Rev. Hy. Shaen Solly, M.A., and Mr. Hy. J. Ellis.

Botanical Section.

1915.
 April 12.—Hinton Admiral, by Mr. R. V. Sherring, F.L.S.
 May 6.—Trigon Mill, by Mr. R. V. Sherring, F.L.S.
 May 20.—Wareham and Stoborough, by Mr. R. V. Sherring, F.L.S.
 June 12.—South Haven and Littlesea, by Mr. R. V. Sherring, F.L.S.
 July 3.—Hamworthy, by Mr. R. V. Sherring, F.L.S.
 Sept. 23.—Fungus Foray in the New Forest, by Mr. J. F. Rayner, F.R.H.S.

Entomological Section.

- June 5.—Verwood.
 June 19.—Hod Hill.

Geographical Section.

1915.
 June 26.—“The Valleys of the Bourne,” by Mr. Geo. de Castro, M.R.C.S., and Mr. W. J. Woodhouse, A.C.P.

Geological Section

1915.
 April 10, 17, 24.—Field Excursions for the study of Local Geology and Physical Geography, by Mr. W. Munn Rankin, M.Sc., B.Sc.
 May 8.—Highcliffe, by Mr. W. Munn Rankin, M.Sc., B.Sc.

Photographic and Record Section.

1915.

June 5.—Creech Grange and Lulworth Cove, by Mr. R. Y. Banks and Mr. E. Dodshon.

Physical Section.

July 7.—Broadstone Lavender Works, by Mr. Hubert Painter, B.Sc., F.C.S., and Mr. Hy. Le Jeune.

The Lectures held during the Winter Session were fully up to their usual high level.

Among the Sectional Lectures was a series treating of Lime from the Physical, Geological, Geographical, and Botanical aspects, followed by a General Lecture on its application in the Arts and Industries, and it has been proposed to adopt this plan in the coming session in connection with some other kindred subject.

At the last Annual Meeting Sir Daniel Morris, K.C.M.G., J.P., M.A., etc., was unanimously re-elected President, and gave his Presidential Address on November 14th.

It is a pleasure to add that he has kindly consented to be nominated as President for the coming year.

The Mayor and Corporation have invited the British Association to hold their meeting in Bournemouth in 1917, and a strong deputation went to Manchester, where the meeting was held this year. Sir Daniel Morris attended as delegate from this Society and Dr. S. McCalmont Hill, one of our Vice-Presidents, joined with him in strengthening our representation.

The General Committee accepted the invitation unanimously and with great cordiality.

The Society has suffered the loss by death of Dr. Richard Shillitoe, who was a zealous and valued worker in the Botanical Section, and for a short time previous to his death had occupied the position of Secretary to the Zoological Section.

The Council also regrets the loss by death of Mr. Geo. Ashby, Mr. C. C. Philpott, Mr. A. H. Searle, late Mayor of Christchurch, and the Rev. Geo. Thompson, M.A., who left to the town his Geological Collection.

The Council further regrets that Mr. George de Castro, M.R.C.S., who has been Chairman of the Geographical Section since 1910, is unable through ill health to continue in that office, and desires to express its thanks to him for his valued services.

By the appointment of Mr. Thos. Capper, M.A., B.Sc., as Joint Hon. Secretary, the Society has secured a valued member of the Council.

The Council desires to express its thanks for, and appreciation of, the kind services of Mr. W. Parkinson Curtis and his brother, Mr. E. Harker Curtis, who are arranging the collection of Birds' Nests and Eggs, made by the late Dr. Batley, which was purchased by the Society last year.

The very fine series of over 100 specimens of Guillemots' Eggs is now available for examination. They show almost the entire range of variation.

The principal donations to the Society's Collections were:—

70 Sheets of Plants, mostly local, by Mr. R. V. Sherring, F.L.S.

65 Sheets of Mosses.

45 Sheets of Confervæ, Ulvæ, etc.

A bunch of 7 cones of *Pinus muricata*.

A bunch of 5 cones of *Pinus Pinaster*.

By Mr. Hy. Backhouse, F.R.H.S.

A bunch of 5 cones of *Pinus insignis*, by Sir Daniel Morris.

A collection of Cape Heaths, by Mrs. Bolitho.

Galls caused by the Larvæ of *Diastrophus Rubi* on the common bramble, and a Globe Fish, set up and varnished, by Mr. Geo. G. Hamilton, F.R.C.S., F.R.H.S.

A collection, by the late Dr. Shillitoe, of Snakes preserved in spirit, by Mrs. Shillitoe.

Among books presented were:—

“Spiders of Dorset,” by the Author, the Rev. O. Pickard-Cambridge.

Sinell's “Prehistoric Times and Men in the Channel Islands,” by Mr. A. Whiting.

Heywood Sumner's “Excavations on Rockbourne Down,” by the Rev. Hy. Shaen Solly, M.A.

Noel Humphrey's “Ancient Coins,” by Mr. R. V. Sherring, F.L.S.

The following works have been purchased and added to the Library:—

Morey's “Guide to the Natural History of the Isle of Wight.”

Miss Pearce's “Photographic Atlas of Diptera.”

“Report on the Excavations at Hengistbury Head, by the Research Committee of the Society of Antiquaries.”

In conclusion, the Council desires to record its appreciation of the kindness of the various owners who have given permission to visit their residences and grounds, and also to express its best thanks to the donors of gifts to the Society, not enumerated, and to the Lecturers and Conductors of Excursions for their services, which have been much appreciated.





The late GEORGE GIBSON HAMILTON, M.B., F.R.C.S.

The late George Gibson Hamilton, M.B., F.R.C.S.

WE deeply regret to record the death of Mr. George Gibson Hamilton, which took place after a short illness on December 19th, 1915. He was a Vice-President and Chairman of Council, and had taken a very active part in the work of the Natural Science Society. Mr. Hamilton belonged to a family well-known in the medical world. He was a graduate of the University of Edinburgh, and qualified as M.B., C.M., Edin., 1887; F.R.C.S., Eng., 1879; F.R.C.S., Edin. (exam.), 1885; L., 1879; L.R.C.P., Edin., 1879 (*Univ. and R.C.S., Edin.*). After being associated with distinguished surgeons such as Sir Patrick Watson and others at Edinburgh he was appointed Resident Surgeon at the Northern Hospital at Liverpool in 1881. He was also attached to the Liverpool Infirmary for Children—one of the best known special hospitals in the North of England. From information kindly contributed by Dr. Peter Davidson, a close friend of Mr. Hamilton, we learn "that having gained considerable experience and practice in surgery Mr. Hamilton was appointed Honorary Surgeon to the Northern Hospital and later Honorary Surgeon to the Royal Infirmary, in the wards of which the teaching and training of the students of the University of Liverpool was carried on. He thus occupied a premier position as consulting and operating surgeon in Liverpool. His consulting rooms were in Rodney Street—the Harley Street of Liverpool. Mr. Hamilton thus became widely known in the medical and social life of Liverpool and was a general favourite. He was a skilful surgeon and performed many difficult operations with brilliant success. His retirement from practice in Liverpool was the cause of general regret. In private life Mr. Hamilton was a buoyant optimist, full of energy and enthusiasm. He had many interests. He was a good golfer, a cheerful, hardly ever a desponding, opponent, and fishing, gardening, and photography were relaxations in which he delighted." Dr. Davidson concludes: "The announcement of Mr. Hamilton's sudden death has been a great shock and grief to his many friends in Liverpool. All who knew him and his wife feel the deepest sympathy with his widow and young children."

Mr. Hamilton left Liverpool in 1908 and settled with his wife and family at Boscombe Place, near his father-in-law, Mr. Walter Child Clark. Here he found abundant scope for his love of gardening and in addition took a deep practical interest in all matters relating to science and horticulture. He was elected on the Council of the Natural Science Society in 1910 and became a Vice-President and Chairman of Council in 1914. His first lecture on "Micro-Cinematography" delivered at St. Peter's Hall in 1911 was greatly appreciated. In 1912 he gave an interesting account, with illustrations, of the "Diseases of Animals and Plants." This was followed in 1913 by a graphic account, fully

illustrated, of a journey "From Christiana to Bergen, across Norway, by the Valdres Route." A fourth lecture on "Plant Galls," illustrated by photographs in colours, was delivered in 1914, and on December 9th, 1915, the day he was attacked by the illness from which he died, he was to have delivered a fifth lecture on "Experiments with BacterIALIZED Peat," supplemented by a description of "Local Galls collected during the summer." A special feature of all Mr. Hamilton's lectures was the use of photographs in colours taken by Mrs. Hamilton and himself. Their series of slides numbered several hundreds, and comprised the most interesting views and trees in the New Forest as well as striking features in some of the best gardens in the Bournemouth area.

The occasion when Mr. Hamilton had full scope for the exercise of his wonderful energy and powers of organisation was the Congress of the South-Eastern Union of Scientific Societies held at Bournemouth in June, 1914. He was Hon. Treasurer and Chairman of the Hospitality Committee and took a leading part in bringing together and arranging a very interesting scientific exhibition and other features of a *Conversazione* given by the Mayor of Bournemouth, Dr. S. McCalmont Hill, at the Municipal College. He was also associated with Mr. Walter Child Clark in entertaining the members of the Congress at a garden party at Michelgrove House. On the same occasion he served as an admirable guide to the interesting geology of the Honeycomb Chine, adjoining Boscombe Place. During the greater part of his life at Bournemouth Mr. Hamilton was a warm supporter of the Horticultural Society, and up to his death he filled the office of Hon. Secretary. He was also a Fellow of the Royal Horticultural Society and delivered lectures illustrated by photographs in colours, in London, Manchester, Liverpool, and Edinburgh.

After war broke out Mr. Hamilton, as a leading authority in surgery, was appointed Chairman of a Committee entrusted with the erection of extra wards for the reception of wounded soldiers at the Boscombe Branch of the Royal Victoria and West Hants Hospital. Latterly, he regularly attended the arrival of relays of wounded soldiers at the Boscombe Station and allotted them to the care of the several medical officers connected with the Hospital.

The representative character of those who attended his funeral at the Bournemouth Cemetery on December 22nd bore full testimony to the high regard and esteem in which Mr. Hamilton was held by all who had been associated with him and who deeply deplored the loss of a large hearted friend and devoted colleague.

D.M.

List of Members.

Revised to 7th December, 1915.

* HONORARY MEMBERS. † PAST PRESIDENTS. A ASSOCIATE MEMBERS*

Members elected since August 1st in Italics.

Members resigned since September 30th, in brackets [.....].

A

Abbott, A. J.	Strathmore, 23, Westby Road, Boscombe
Alabaster, Lady	Dil Aram, 36, Sea Road, Boscombe
Alder, Mrs.	East Grove, Lymington
Alder, Miss Evelyn	" "
Aldridge, Mrs.	Denewood, 55, Alum Chine Road
[Aldridge, Miss Mooring]	Westover, 4, Portarlington Road
[Aldridge, Miss C. Mooring]	" "
[Aldridge, Miss E. Olive Mooring]	" "
Alexander, Saml. J.	Abbotslea, 5, Surrey Road
Allan, Alexr.	Bylands, Boscombe Cliff Road
Allen, Rev. F. A., M.A.	Staffa, Wellington Road, Parkstone
Allis-Smith, Miss E.	Martello Towers, Branksome Park
Allwood, Miss C. A.	The Chimes, 5, Crabton Close Road
Andrews, W.	Chineside, 15, Studland Road
Anstice, Mrs. M.	Bryher, Tower Road
Anthony, H. E.	Rosendale, Branksome Wood Road
Archer, J. W.	Windlesham, 5, Bradley Road
Archer, Mrs.	" "
Armstrong, Mrs.	27, Cecil Road, Boscombe
<i>Arundel, John T., F.R.G.S.</i>	Savoy Hotel, Bournemouth
[Ashby, Geo.] deceased	Rosenheim, 8, Crabton Close Road
[Aston, J. J.]	Habberley, 6, Hamilton Road, Boscombe
Atkins, Dr. F.	Cathay, 44, Alumhurst Road
Atkins, Mrs.	" "
Atkins, W.	The Hermitage, 40, Wimborne Road
Atkins, Mrs.	" "
Atkins, Miss Bessie	Glen Lee, 10, Alumdale Road
Atkinson, Miss	Berwyn, Ashley Road, New Milton

B

Backhouse, Hy., F.R.H.S.	Yelland, 23, McKinley Road
Bain, Mrs.	14, Oxford Avenue, West Southbourne
Bainbridge, Surgeon-General	Vernon, Sandecotes Road, Parkstone
[Bancroft, J. H.]	Withens, 73, Chatsworth Road
Banfield, Col. R. J. F., C.B.	Park View, 42, Poole Road
Banks, R. Y.	Egerton, 12, Portchester Road
Barlow, E. W., B.SC., F.R.A.S.	32, New Park Road, West Southbourne
Barnes, Oliver Geo.	Glen Lee, 1, Suffolk Road
Barracrough, Aug., M.A.	56, Richmond Wood Road
(Cantab), F.R.G.S.	
Barratt, J. Hayes	Brundon, 2, Surrey Road
Barrington, W. J.	Heather Dene, Penn Hill Avenue, Parkstone
Bartlett, H. F. D., F.E.S.	1, Myrtle Road, Richmond Park

Bartlett, T. O.
 Beck, Rd., F.E.S.
 [Bell, T. G., M.D.]
 Benison, F.
 Benison, Mrs.
 [Bennett, Miss Bessie]
 Bennett, Miss E. C.
 *Bennett, H. Morden
 Bilton, Miss C. E.
 Blackall, Miss E. E.
 Blackett, C. H.
 Blackett, W. Eggleston
 Blackledge, Miss K., B.A.

Blondel, Mrs.
 Blosse, Rev. R. C. Lynch
 Blosse, Mrs.
 *Bond, F. Bligh, F.R.I.B.A.
 Bradbury, Miss
 Bradbury, Miss Alice
 Bradbury, Miss Edith
 Brazier, J. J.
 [Brett, G. H.]

[Brett, Mrs. E. K.]
 [Brett, Miss J. E.]
 [Brett, Miss K. M.]
 Bright, Percy, F.E.S.
 Brown, John H.
 Brown, Mrs.
 Brumell, Geo., A.R.I.B.A.
 [Brumell, Mrs.]
 Bulfin, Ignatius, B.A.
 Bulfin, Mrs.
 [Burt, Mrs.]
 [Burt, Miss D. M.]
 Burton, Jas.

Wilts and Dorset Bank, Westbourne
 Red Lodge, 49, Portchester Road
 38, Poole Road, Branksome
 Aldborough House, 14, Rosemount Road

West View, 31, Churchill Road, Boscombe
 Bonavista, 19, Boscombe Spa Road
 Manor Lodge, 20, Manor Road
 Dilkhush, 25, Parkwood Road, Boscombe
 Leamfield, Castlemain Road, Stourwood
 Rosapenna, 16, McKinley Road
 Blanchland, 21, McKinley Road
 Terra Firma, Cellars Farm Estate, South-
 bourne

Redroofs, Ipswich Road
 Hawthorn Dene, 10, Cavendish Road

Glastonbury
 La Bocca, 2, Portarlington Road

Harbledown, 5, St. John's Avenue, Bos-
 combe

Fairfield, 9, Wimborne Road
 The Bluff, Canford Cliffs

Maori, Richmond Park Avenue

The Den, 26, Knole Road

Oakleigh, 13, Snowdon Road

163, Richmond Park Road

C

Cameron, Miss
 Capper, Thos., M.A., B.Sc.
 [Capper, Mrs.]
 [Capper, Miss]
 Carus-Wilson, C., F.R.S., Edin.,
 F.G.S.

[Cavit, C. G.]
 Chandler, S. Whitty, B.A.
 [Chandler, Mrs. Whitty]
 Chapman, F. F.

Chapman, Miss
 Charsley, Mrs.
 [Chidell, Miss F. K.]
 AChilver, Miss Kathleen M.
 AChisman, Miss E. M.

Clark, Walter Child
 [Clarke, Wm. Edward, B.A.]
 [Cocks, Lt.-Col. H., M.B., late
 R.A.M.C.]

Little Forest House, 19, Bath Road
 Ropley, Stirling Road

Altmore, Waldegrave Park, Strawberry
 Hill, Middlesex
 and Royal Societies' Club, S.W.
 Conewood, Stirling Road
 St. George's, Cecil Road, Boscombe

Penrhyn, Chessel Avenue, Boscombe
 Manor

Camborne, Belle Vue Road, Southbourne
 Nairn, 8, Suffolk Road South
 79, Richmond Park Road
 Heatherlea, 11, Cowper Road, Moordown
 Michelgrove House, Boscombe
 Roydon, Kingsbridge Road, Parkstone
 Whitekirk, Belle Vue Road, Southbourne

Coddington, E. F.	St. Frideswide, 94, Southbourne Road
Collins, W. F.	Vellore, Overcliff Drive
Compton, Rev. D. G.	The Downs, Clifton Road, Southbourne
Cooke, F. I.	Corona, Annerley Road
Cooper Ernest	100, Old Christchurch Road
Cooper, Mrs. J. Omer	6, Queensland Road, Boscombe
Cooper, J. Omer	" " "
Cooper, Wilfrid Omer	" " "
Cooper, Rev. W. H. Windle,	The Birks, 2, Branksome Wood Road
M.A., F.R.G.S.	
Cooper-Dean, Mrs.	The Old Vicarage, Pokesdown
Corbet, Rev. Alex.	Pemlin, Richmond Park Avenue
Cotes, Sir Merton Russell,	East Cliff Hall
J.P., F.R.G.S., M.J.S.	
Cotes, Lady, F.R.S.L., M.J.S.	" " "
Cotes, H. V. M.	Meyrick Park House, Meyrick Park
Cowie, Dr.	Bonaccord, Westminster Road
†Crallan, Dr. G. E. J., M.A.,	Gouray Lodge, Gorey, Jersey, Channel
M.B., M.R.C.S.	Islands
Crapper, H. Sugden, L.D.S.,	Fatshan, Parkstone Road, Poole
M.R.C.S., L.R.C.P.	
Crespi, Dr.	Cooma, Poole Road, Wimborne
Crowther, Miss Violet	Shelbrook, Brunstead Road, Westbourne
Curme, Decimus, Surg. Lt.-	Child Okeford, Blandford
Col.	
Curme, Mrs.	" " "
Curtis, W. Parkinson, F.E.S.	The Square
Curtis, Eustace H.	Aysgarth, Poole

D

[Dacombe, J. M. J.]	27, Holdenhurst Road
*Dale, Wm., F.S.A.	The Lawn, Archer's Road, Southampton
Davenport, Miss C.	Torvaine, Parkstone
[Day, Miss]	Fairhurst, Barrack Road, Christchurch
de Castro, Geo., M.R.C.S. (Eng.)	Sunnydene, 76, Drummond Road
de Castro, Mrs.	" "
de Castro, Miss Mary B.	" "
de Paiva, R. A.	San Remo, 13, Carysfort Road
de Paiva, Mrs.	
Dickson, Col. W. D.	Southill, 32, Dean Park Road
Dickson, Mrs.	" "
*Dixon, Dr. J. R. L.	Torbay House, Torbay Road, Paignton
[Dodd, Mrs. J. R.]	Killarney, 140, Richmond Park Road
Dodshon, Edwin, L.L.B.	Lloyds Bank Chambers
Dolby, Geo. Alex., F.R.G.S.	Nazdar Hall, Branksome Park
Druitt, J., J.P.	Avebury, 10, Madeira Road
Druitt, Robt.	Carfax, Christchurch
[Dudding, Mrs.]	22, New Park Road, West Southbourne
Dunning, Mrs.	The Homestead 21, St. Clement's Road
Dyer, J. Herbert	Hillcrest, Queen's Park West Drive

E

Earle, Dr.	The Wyke, Brunstead Road
Edwards, Aubrey	The Pinetum, Wellington Road, Park-
	stone
[Edwardson, A. Rowley]	Rosmead, 9, Richmond Park Crescent
Eiloart, Miss	Glegyle, Chester Road, Branksome Park

Ellis, Hy. J.
 Else, Miss
 Elwes, Captain G. R., J.P.
 Evans, P. H. L., M.A.

Chesterford, Richmond Park Avenue
 Esterel, 31, West Cliff Road
 Bossington, 14, Knyveton Road
 Stirling House, Manor Road

F

Fairles, Gustavus W.
 Farrington, Miss
 Fielding, Dr. Thos., M.D.
 AFirbank, Miss, L.L.A., A.C.P.
 [Foster, Miss Amy] deceased
 Fraser-Hird, Rev. F. M.A.
 Fraser-Hird, Mrs.
 Frean, G. M.
 Frean, Mrs.
Frean, Miss Eleanor
 Freeman, Miss Emily
Freeman, Geo. Broke
 French, J. M.
 Frewin, Alfred
 Furlong, R. O'B., C.B., M.A.,
 J.P.

Bank House, Alexandra Road, Parkstone
 Canterbury House, 25, Marlborough Road
 Halford House, West Hill Road.
 5, Buchanan Avenue
 Hendra, 2, Studland Road
 Eaglehurst, 16, Parkwood Road
 " "
 Cranicombe, Branksome Avenue
 " "
 " "
 Corona, Annerley Road
 Hasland, 13, Grosvenor Road
 The Gables, 12, Wharnciffe Road
 Rowherne, 43, Branksome Wood Road
 Maesbury, 3, Cavendish Road

G

Gardiner, Miss F. M.
 George, Arthur Durancé
 AGill, Edwin R., A.R.C.A.
 Girdlestone, Miss Lucy
 Gissing, Admiral C. E.
 Goodall, T. B., F.R.C.V.S., F.L.S.
 Gosse, Wm., M.D., D.P.H.
 Graham, F. A.
 Grange, Dr. W. D'Oyly
 Gray, A.
 Gray, Geo. W.
 Gray, Mrs.
 AGreen, C. B.
 [Green, Philip Alfred]
 [Green, Mrs.]
 Greves, E. Hyla, M.D., M.R.C.P.
 Greves, Stanley S. Hyla
 [Groundwater, Saml.,
 A.M.I.MECH.E.]
 [Groundwater, Mrs.]
 AGuest, G., B.A.]
 AGuy, Miss]

Heather Cottage, Talbot Hill, Winton
 Alderholt, 6, Clarendon Road
 Public Library, Poole
 Ruabon, Richmond Park Crescent
 Homestead, Queen's Park South Drive
 Purewell Cross, Christchurch
 The Links, Sandecotes Road, Parkstone
 21, Beaulieu Road
 11, McKinley Road
 Woodville, 26, Melville Road, Winton
 Darena, 15, Wellington Road
 " "
 Linden Villa, Argyle Road, Swanage
 Toftrees, 97, Southbourne Road
 " "
 Rodney House, Poole Road
 " "
 Honam, 17, Grosvenor Road
 " "
 St. Paul's School " "
 " "

H

Haig, W. S.
 AHall, Chancellor T. C.
 Hamilton, G. G., M.B., F.R.C.S.,
 F.R.H.S.
 Hamilton, Mrs.
 Hamilton, Major Claude
 Hammer, Miss A. G.
 Hannah, Rainsford

Birchwood Cottage, Birchwood Road,
 Parkstone
 Wyngreen, Maxwell Road
 Boscombe Place
 " "
 Westholme, Foxholes Road, Southbourne
 66, Lowther Road
 Stanmore, 49, Branksome Wood Road

[Hardiman, Miss E. E.]
[Hardiman, Miss E. M. C.]

AHarding, Miss
Hardwick, Philip

Harris, Miss K.

Harrison, Henry

Hartley, Dr. J.

Hartley, Mrs.

Hatton, Rev. C. O. S., B.A.
(Camb.)

Heaton, Guy, M.A.

Henslow, Rev Professor G.,
M.A., F.L.S., F.G.S.

Heywood, Col. J. M.

Hill, S. McCalmont, D.C.L.

Hinton, Miss

Hippisley-Smith, Rev. A.

[Hoare, Miss Annie]

Holmes, C. F.

Holmes, Mrs.

Holmes, Miss M. A.

Holmes, Miss C. S. M.

Homer, L. V. C.

Honeyman, G.

Honeyman, Mrs.

Honeyman, Miss M. W.

Hudson, F.

Hudson, Mrs.

16, Branksome Terrace, Poole Hill

Alma Road " Council School

21, Commercial Road

Trescott Grange, Harvey Road, Boscombe

Southlea, Durley Road, West Cliff

62, Portchester Road

Hinton Admiral " Vicarage, Christchurch

St. David's, 51, West Cliff Road

Danehurst, 40, Branksome Wood Road

Sutherland Hall, South Cliff

The Club, Boscombe

Welcombe, 1, Argyll Road, Boscombe

Knowlton House, 22, Surrey Road

Westdale, 7, Cambridge Road

Brackenwood, 37, Southern Road, West
Southbourne

4, Beaufort Road, West Southbourne "

Carron, 54, " Southcote Road

Stormont, Milton Road

" "

" " Peñarol, Parkstone

" "

I

Ibbett, F. W., M.A.

[Ingram, Edgar LL.,
M.INST.E.E.]

Instone, Thos.

Instone, Mrs.

Instone, Allan C.

Instone, Mrs. A. C.

Isaacs, Charles

[Isaacs, Geo. H., B.A.]

[Isaacs, Mrs.]

Central Education Office, Yelverton Road
Caldicott, St. Osmund's Road, Parkstone

31, Portchester Road

" "

" "

" "

Rosemount, Balcomb Road, Branksome
Park

Hillsley, Caledon Road, Parkstone

" " "

J

Jackson, Miss Cicely M.

James, Thos. Bath

James, Mrs.

James, Miss G. Gladys

Jeffery, T. J. P.

Jeffery, Miss Ruby

Jeffery, Miss E. S. M.

Jennings, Miss C. E.

[Jermyn, F. L.]

[Johnson, Mrs. L. E.]

AJones, W.

Jones, W.

Sunny Hill, 9, St. Stephen's Road

Trevenen, Howard Road

" "

" " Meldon, Ormonde Road

" " The Haven, 38, Sea Road, Boscombe

Edenhurst, Sandbanks Road, Parkstone

61, Old Christchurch Road

Moreton, Flaghead Road, Canford Cliffs

Council School, Boscombe

254, Old Christchurch Road

K

Kay, A. J.
 Kaye, J. E.
 Keevil, W. C.
 [Keighley, Miss G.]
 Kenrick, Archibald
 Kenrick, Miss M.
 [Kent, Geo. G.]

Keogh, Duncan
 Keogh, Mrs.
 Killick, H. F.
 [King, Mrs.]
 Kirkby, Mrs. J.

Winsgarth, 141, Lowther Road
 Tynedale, 38, Portchester Road
 Eglinton, Kinson, Bournemouth
 6, Stourcliffe Avenue, West Southbourne
 Broom House, 37, West Cliff Road

Ballinhassig, 12, Southwood Avenue, West
 Southbourne
 The Warren, 13, Richmond Wood Road

Rawdon, 9, Marlborough Road
 Lyss, Guildhill Road, Southbourne
 Inglewood, Richmond Park Avenue

L

[Langley-Smith, W.]
 [Langley-Smith, Miss]
 [Langley-Smith, Miss R.]
 Lattey, F.
 [Lattey, Mrs.]
 [Leach, Miss M. F.]
 Leigh, Miss

Alumhurst Tower, 115, Alumhurst Road

" "

Alyngby, 44, Stourcliffe Avenue, Stourwood

The Five Ways, Parkstone
 Wood Lodge, Penn Hill Avenue, Park-
 stone

55, Ashley Road, Upper Parkstone
 c/o Mr. de Paiva

Gwestfa, 18, Richmond Wood Road

6, St. John's Avenue, Boscombe

Rodborough Grange, 66, West Cliff Road

Le Jeune, Hy.
 Lendrum, Miss A. M.
 Letcher, Mark Jameson
 Lewis, Miss Constance F.
 *Liddiard, Jas. E., F.R.G.S.,
 M.N.G.S. (U.S.A.)

Edmondsham, Salisbury
 Croftmoor, 23, Dean Park Road
 Bolingbroke, Knole Road
 Shalimar, Wilderton Road, Branksome
 Park

" " "

*Linton, Rev. E. F., M.A., F.L.S.
 Lucas, Arthur
 Lupton, Miss
 Lyon, Claude

Lyon, Mrs.

M

Somerled, 29, Meyrick Park Crescent

Inglennook, 29, Parkwood Road
 Froebelheim School, 47, Lowther Road

Killarney, Munster Road, Parkstone

Tre Veau, Colville Road, Boscombe Park

St. Andrew's School, Malmesbury Park

Cliff Cottage, Boscombe Manor Park

" "

" "

Heather Bank, Richmond Hill

Castle Court, 23, Boscombe Spa Road

38, Crabton Close Road

Nethergrove, Portesham, Dorchester

Macalister, R., M.INST.C.E.
 Macalister, Mrs.
 McBean, Miss J.
 A McBean, Miss S.
 [McCarthy, J. D., M.D., C.M.G.]
 [McLorg, Miss Adeline]
 A Mackay, Miss
 Mackelvie, J. Mc Intosh
 Mackelvie, Mrs.
 Mackelvie, Miss Esther H.
 Mackelvie, Miss Doris
 Mackenzie, Dr. Ridley
 [Mahs, Miss E. M.]
 Mann, W. P., B.A.
 March, H. Colley, M.D., F.S.A.
 M.R.S.A.I., F.A.I.
 *Markwick, Col. E. E. C.B.,
 F.R.A.S.

Filchin, Havant, Hants

32, Southbourne Road

Martin, Miss Florence

- Martland, Dr. T.
 Mate, Ald. C. H., J.P.
 Mate, Sidney J.
 Maude, W. C., J.P.
 [May, Alfred J., I.S.O.]
 [May, Mrs.]
 Maybery, Joseph, J.P.
 Maybery, Mrs.
 [Mesham, Miss Isabel]
 Michell, Theo., M.INST.C.E.
 Michell, Mrs.
 [Miller, Joseph, L.D.S., R.C.S. (Edin.)]
 [Miller, Mrs.]
 [Millward, A. H.]
 [Millward, Mrs.]
 [Montgomery, Miss L. F. M.]
 Moon, Miss
 Moon, P. G. G., F.C.S.
 Moore, F. W.
 [Moore, Montie S.]
 Moorhead, Dr.
 *Morris, Sir Daniel, K.C.M.G., J.P., M.A., F.L.S.
 Morris, Lady
 [Morton, Miss C. I.]
 Moss, Miss
 Muncaster-Jones, Thos.
 Muncaster-Jones, Mrs.
 Muncaster-Jones, Miss
- Standish House, Fitzharris Avenue
 Elim, 3, Surrey Road South
 10, Landseer Road
 Brackenwood, Gervis Road
 Boa Vista, Colville Road, Boscombe
 Langley Dene, 55, Wellington Road
 Cairnsmuir, 8, Durrant Road
 Merton, 54, Christchurch Road
 Wenonah, 37, Poole Road
 St. Aubyn's, 201, Holdenhurst Road
 Everton, 49, Westby Road
 c/o Mr. Maybery
 Hill Croft, Alexandra Road, Parkstone
 Goathland, Tower Road, Branksome Park
 Imperial Hotel
 14, Crabton Close Road
 Castle Court, 23, Boscombe Spa Road
 The Grange, 52, Westby Road
 Hillingdon, Brunstead Road
 „ „ „ „ „ „

N

- Neale, J., B.A.
 Neale, Mrs.
 Neale, Miss D.
 Neave, Mrs.
 Neave, Miss
 [Neve, Miss G.]
 Nicholl, G. B. T., J.P.
 [Noble, Miss E. I.]
 Norton, John J.
 Norton, Mrs.
- Clonenagh, Montagu Road
 „ „ „ „ „ „
 Lingdale, 73, Lansdowne Road
 „ „ „ „ „ „
 Merridale, 11, Westby Road
 Santos, Capstone Road
 Castle Court, 23, Boscombe Spa Road
 Ashton Court, Branksome Park
 „ „ „ „ „ „

O

- [Offey-Shore, Miss Janet D.]
 Oke, A. W., B.A., LL.M., F.G.S., F.S.A.
 Old, Robt. H.
 Oliver, Mrs. E.
 Ord, Dr. W. T., F.G.S.
- Wharnccliffe, Queen's Road, Bournemouth.
 Road, Parkstone
 32, Denmark Villas, Hove, Brighton
 5, Westover Colonnade
 Teviotdale, Milton Road
 Greensted, 14, Madeira Road

P

- Pain, Miss M. T.
 Painter, Hubert, B.Sc., F.C.S.
 Painter, Mrs.
 [Palmer, H. B.]
- Membury, 52, Wellington Road
 29, Talbot Road, Winton
 New Home, Tuckton, Southbourne

- Pate, Rev. J.
 Pechell, Sir A. Brooke, Bart.
Penrose, Dr. Francis Geo.,
 M.D., F.R.C.P., F.Z.S.
 Pestell, Miss
 Phillips, Mrs.
 [Philpott, C. C.] deceased
 Philpott, Mrs.
 *Pickard-Cambridge, Rev. O.,
 M.A., F.R.S.
 Platnauer, Hy. Maurice, B.Sc.
 Player, Mrs. Wm.
 Pollard-Urquhart, M. A.
 M.INST.C.E.
 Pollock, Mrs.
 A Povah, Edwin
 Powell, M.
 Preston, Donald W.
 Price, Miss Annie N.
 [Pugh, Miss]
 Pullman, A.
 Pyemont, Miss Rosa U.
 Spencer House, Constitution Hill, Park-
 stone
 c/o Messrs. Holt and Co., 3, Whitehall
 Place, S.W.
 Snowdenham, 44, West Cliff Road
 Engelberg, Surrey Road
 43, Alumhurst Road
 Hinxhill 68, Westcliff Road
 " " "
 Bloxworth Rectory, Wareham
 St. Olaf, West Over Cliff Drive
 Westfield, 3, Surrey Road
 Woodlands, Percy Road, Boscombe
 43, Wellington Road
 Woodseat, Southern Road, Stourwood
 Edenhope, Chessel Avenue, Boscombe
 Manor
 Bank Chambers, Yelverton Road
 Shelford Lodge, Southwood Avenue, West
 Southbourne
 The Albynes, 9, St. Winifred's Road
 Seacroft, Cliff Drive, Southbourne
 32, Hawkwood Road, Boscombe

R

- ARainer, A. J.
Aralph, E. W.
 Ramsay, Miss
 Rankin, W. Munn, M.Sc.
 (Leeds), B.Sc. (Lond.)
 †Ransome, Dr. A., M.A., F.R.C.P.
 *Rayner, J. F., F.R.H.S. [F.R.S.
 *Reid, Clement, F.R.S., F.L.S.,
 F.G.S.
 [Reid, Mrs. G. A.]
Richmond, Miss K. E.
 Ritson, Mrs.
 Roberts, V. C., B.A.
 Robertson, Mrs.
 *Rogers, Rev. Moyle
 Rogers-Barns, Miss
 Rooke, Miss S. G.
 Rooper, Miss C. Agnes
 *Roper, Miss Ida M., F.L.S.
 Ross, Rev. T. S.
 Ross, Col. W. H.
 [Rowcliffe, H. S.]
 [Rowcliffe, Mrs.]
 Rowe, Miss R. Vidal
 Rudkin, Miss F.
 Rumsby, Mrs. S.
 Russell-Wright, Rev. T.
 Rutherford, R. C.
 [Rutherford, Mrs.]
 Rutter, G. H., M.B.
 ARyde, Kenneth A.
 6, King's Park Road
 Alma Road Council School
 Redroofs, Ipswich Road
 Municipal College, Lansdowne
 Sunnyhurst, 7, Dean Park Road
 Swaythling, Southampton
 Milford-on-Sea
 Sticklepath, 2, Durley Road
 7, Davenport, Surrey Road
 Plas Pinwydd, 2, Durrant Road
 41, Parkwood Road
 Struan, Alum Chine Road
 Chetnole, 11, Grosvenor Road
 Bevois Cottage, 25, King's Park Road
 Norbury, 53, Paisley Road
 Pen Selwood, 13, Gervis Road
 4, Woodfield Road, Redland, Bristol
 Lennox, 16, Foxholes Road, Southbourne
 Ambleside, 9, Dean Park Road
 Rutland Lodge, 7, Argyll Road
 " "
 Viwa, 9, McKinley Road
 Ivel Cottage, 25, Hamilton Road, Boscombe
 Ennisfall, Fitzharris Avenue, Charminster
 Park
 92, Richmond Park Road
 South Dene, 1, Groveley Road
 " "
 Roxbury House, 22, Poole Road
 47, St. Swithun's Road

S

- [St. Leger, Col.]
 [Salkeld, Dr. Chas.]
 [Salkeld, Mrs.]
 A.Saunders, Hugh A., B.A.,
 F.R.G.S.
 Saunders, Miss L. Metta
 Scarlett, Miss A.
 Scarlett, Miss K.
 Scarlett, Miss M.
 A.Scattergood, J.
 Scholes, Denton
 Scholes, Mrs.
 Scott, J. H., M.E., M.I.M.C.E.
 Scott, W. H., M.A.
 [Sells, H. Martin]
 Sharp, Chas.
 Sherring, R. V., F.L.S.
 Sherring, Miss O. L.
 [Shillitoe, Dr. R.] deceased
 Sidgwick, Chas.
 Sidgwick, Mrs. C.
 Simcox, Miss Winifred
 [Simmons, Dr. Harold, M.B.]
 B.S.
 [Smith, Chas. Sharpe]
 Smith, Miss Hope
 Smith, Rev. Philip H.
 Smyth, Dr. W. Johnson,
 M.D. (Edin.).
 Smythe, J. H. Ralph, J.P.
 Smythe, Mrs.
 Solly, Rev. Hy. Shaen, M.A.
 Southby, Miss E. H.
 Spencer, J. F.
 [Spencer-Bower, Anthony, C.E.]
 Spencer-Bower, Mrs.
 [Spriggs, A. T.]
 [Spriggs, Mrs.]
 Stokes, R.
 [Story, W. F.]
 Stuart, C. M.
 Stuart, Mrs.
 Stuart, Miss
 Sutton, H.
 Swain, H. E.
 Swallow, E.
 Sworn, Mrs.
 [Sykes, Chas. Edward]
 deceased
 Sykes, Mrs.
 Sykes, Miss
- Silverton, Lamberhurst, Kent
 Glen Court, 32, Poole Road
 Brookfield House, Swanage
 Pine Cottage, Chester Road, Branksome
 Park
 Fermoy, St. Alban's Avenue
 " "
 " "
 Alma Road Council School
 Craigmoor, 7, Branksome Wood Road
 Kirkby, Linwood Road, Charminster Park
 Hendall, Westminster Road
 Pearlhaven, Canford Cliffs
 Milfield, Langdon Road, Parkstone
 Hallatrow, near Bristol
 Bancroft, Pinecliffe Avenue, Stourwood
 Lindsay House, Lindsay Road, Branksome
 " "
 7, Alma Road, Winton
 Collipreest, 44, Christchurch Road
 Cliff House, Cliff Drive, Canford Cliffs
 Spinney Hill, 44a, Grosvenor Gardens,
 Boscombe
 Pirbright, West Cliff Gardens
 Willstead, 22, Cavendish Road
 Southcote, Alexandra Road, Parkstone
 Twyford Lodge, 17, Cavendish Road
 Glenthorne, 73, Richmond Park Road
 Lea Royd, 48, Westby Road, Boscombe
 The Bryn, Belle Vue Road, Southbourne
 Laverstock, Cliff Road, Boscombe
 Castle Court, 23, Boscombe Spa Road
 Morlais, Milton Road
 " "
 " "
 Ravenshall, 2, Chine Crescent Road
 Sorrento, Studland Road
 Westridge, Sandbanks, Parkstone
 Normandale, 63, Lansdowne Road
 Oak Lodge, Talbot Avenue
 " "
 " "

T

- [Tanner, Miss Nellie]
 Tatchell, Leonard
 Taylor, F. B., B.A.
- Parkside, 191, Richmond Park Road
 23, Arcade
 Thurgarton, 55, Grand Avenue

Taylor, Jas.	61, Lansdowne Road
Thomas, J.	c/o Bright's Stores
[Thompson, C. R.]	Holmwood, Castle Hill, Parkstone
[Thompson, Miss Alice]	" " "
[Thompson, Miss A. C.]	" " "
[Thompson, Miss Ellen]	" " "
Thomson, Dr. J. Roberts, J.P.	Monkchester, 17, Manor Road
Thomson, Mrs.	" " "
Thomson, Matthew	Fircliff, 29, Studland Road
Tickell, Miss S. M.	Boscombe Lodge, 12, Boscombe Spa Road
[Toppin, Mrs.]	Westminster Cottage, Branksome Park
Towsey, Miss E. L.	Moseley, 20, Owls Road, Boscombe
[Treeby, Miss C. S.]	Wyvenhoe, 7, Stourwood Road
[Tucker, Mrs. E. M.]	Boscombe Cottage, 18, Wharnccliffe Road
Tunnard-Moore, J. C., J.P.	Dunedin, 2, Darracott Road, Boscombe Park
Turner, J. E.	Bramley, Surrey Road
Twemlow, Miss Emily E.	Devon Lodge, 83, Alumhurst Road

U

Usherwood, Rev. Canon T. E., M.A.	Bagdale, Parkstone
--------------------------------------	--------------------

V

Veale, Miss Alice G.	Treheer, 17, Westbourne Park Road
Veale, Miss Bertha	" "
[Veale, Miss Clara M.]	" "
Veale, Miss L. H.	" "
Veale, Miss Mary Christina	" "
Vernon, Dr. A. H.	1, Carnarvon Crescent, Boscombe
Vipan, Miss Dora	5, McKinley Road

W

Waldron, Miss F.	Benvenuto, 15, Portarlington Road
Wallace, Wm. G.	The Haven, Sea Road, Boscombe
Walter, Mrs. G. P.	Rusholme, St. Anthony's Road
Warr, Miss Ada	Cottesmore, Pokesdown Hill
Waters, A. W., F.L.S., F.G.S.	Alderley, 2, McKinley Road
Waters, Mrs.	" "
Waters, Mrs. Robt. S.	Dalbury, 4, Knyveton Road
Watts, Col. Sir Wm., K.C.B.	The Priory, 53, Branksome Wood Road
Webber, A. E.	28, Tower Road, Boscombe
Webster, Rev. T.	Devonia, 2, Chatsworth Road
[Welby, Rev. A. A.]	Doveridge, 14, Landseer Road
[Welby, Miss A. B.]	" " "
Wells, H. B., F.R.M.S.	Stalham, 16, Studland Road
Wetherell, Miss	Triana, 21, Harvey Road, Boscombe
Whiting, Albert	Rozel, 7, Pinecliffe Avenue, West South- bourne
Wilkinson, Mrs.	Mon Repos, 36, Grosvenor Gardens, Bos- combe
Willes, W. A.	Elmwood, Cranborne Road
Willes, Dr. Wm.	Ringstead, Milton Road
Williams, Dr. C. E. Campbell	Greystones, Marlborough Road, Canford Cliffs
[Willis, Col. Legge]	Norwood, 21, Grand Avenue, West South- bourne
Wood, W. H.	Arosa, Tower Road, Branksome Park

Woodhouse, W. J., A.C.P.	35, Chatsworth Road, Malmesbury Park
A Woodhouse, Wm.	Attleborough, 34, Wimborne Road
Woollacott, J. C.	Solent View, Belle Vue Road, Southbourne
[Wyatt, Miss H.]	20, New Park Road, West Southbourne

Y

Yates, R. P.	Woodmanton, 35, Wellington Road
[Yeatman, Archibald]	112, Old Christchurch Road
[Youd, Miss L.]	3, Alum Chine Road



RULES OF THE Bournemouth Natural Science Society.

Amended October, 1914.

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|--------------------|---|
| Title | 1.—The title of the Society shall be THE BOURNEMOUTH NATURAL SCIENCE SOCIETY. |
| Objects | 2.—The objects of the Society shall be the promotion of the study of Science in all its branches, by means of Lectures, Field Meetings, the Reading and Discussion of Papers, and the formation of Sections of its members devoted to any particular branch of the Society's work, or by any other means that the governing body of the Society shall deem advisable. |
| | 3.—The Society shall encourage the making of reports on any plant, animal, or object of interest, and where the Society may deem it necessary, shall take such steps as may be advisable to secure any such plant, animal, or object of interest from injury, extinction or destruction. |
| Members | 4.—The Society shall consist of Ordinary, Life, Associate, and Honorary Members. |
| Council | 5.—There shall be a Council of the Society consisting of the Hon. Treasurer, one or more Secretaries, Honorary or otherwise, the Vice-Presidents who have filled the office of President, the Hon. Librarian, the Hon. Editor, the Chairmen of Sections and twelve elected Members.

The Council shall have the general management of the Society. At all Meetings of the Council, five shall form a Quorum. The Council shall elect their own Chairman and Deputy-Chairman for the Year, and shall have power to fill up any vacancies in their number which may occur from time to time. The Council shall have power to appoint Committees to deal with any business that may be delegated to them.

The Chairman, or in his absence the Deputy Chairman, at all Meetings of the Council shall have an original and a casting vote.
The Council shall have the control of the Funds of the Society. |
| Executive Officers | 6.—The Executive Officers of the Society shall consist of the Chairman and Deputy Chairman of Council, Hon. Treasurer, and one or more Secretaries, Honorary or otherwise. |
| | 7.—The Ordinary, Life, and Associate Members of the Society shall be proposed by an existing Member, and seconded by another existing Member, and notice shall be sent to one of the Secretaries of the Society of the names and address of the nominee, and the names of the proposer and seconder. Any such proposed new Member shall be voted for at the next ensuing Council Meeting, and if two-thirds of the Council present and voting shall vote for the proposed new member, such candidate shall become a Member upon payment of the Annual Subscription, and shall receive a card of membership (not transferable) entitling him or her to attend the Meetings of the Society. Members joining during August and September shall be given a card of membership to September 30th of the following year. |
| Ordinary Members. | 8.—Ordinary Members shall pay an Annual Subscription of Ten Shillings, due on the first day of October in each Year. The Annual Subscription for Adult Members of the same family, not exceeding four and residing in the same house, shall be Twenty Shillings, each Member being elected in the usual manner and each receiving a card of membership. |

9.—The Subscription for Life Members shall be Five Guineas. Any Ordinary Member who shall have commuted his Subscription, as provided for in this Rule, shall become a Life Member, but shall not by reason thereof have any different rights from those of an Ordinary Member. Life Members.

10.—Associate Members are those who by payment of an Annual Subscription of Two Shillings and Sixpence are entitled to attend all the General Meetings and Excursions of the Society. They also have the privilege of attending the Meetings and Excursions of one particular Section they may select at the time of their Election, or at the commencement of each Session, their choice being notified by them to the Hon. Treasurer. The following are entitled to become Associate Members on Election by the Council:— Associate Members.

- (a) Teachers in schools who are still engaged in the active duties of their profession.
- (b) Persons, who in the opinion of the Council, although unable to pay the fee for full membership, are by their acknowledged scientific tastes or attainments, likely to prove useful working Members of the Society.

On further payment of Two Shillings and Sixpence Associate Members are admitted to the Meetings and Excursions of all the Sections.

Associate Members shall have no power of voting on the affairs of the Society, or of holding office.

11.—Any person who is either distinguished in Science or has rendered any special service to the Society, may be elected an Hon. Member. Such Hon. Members shall be proposed and elected in the same way as Ordinary Members. Honorary Members

12.—Any Visitors introduced by a Member or producing a Member's card, may be admitted to any Meeting or Excursion of the Society on entering their names and that of the introducing Member in the Society's Visitors' Book. Such privilege not to be granted more than twice to any one person in each Session. Visitors

On the recommendation of the Council or Committee authorised by it, Visitors to Bournemouth desirous of attending the Meetings or Excursions of the Society, may obtain a ticket of admission for the Winter or the Summer Meetings or Excursions at a charge of Seven Shillings and Sixpence. Application to be made to the Hon. Secretary for submission to the Council or Committee authorised by it.

13.—Any Members whose subscriptions are unpaid at the end of the financial year (September 30th), on notice to that effect in writing having been given to them by the Hon. Treasurer, shall be reported to the Council, who shall have the power of removing their names from the list of members.

14.—Resignations should be in writing, and addressed to one of the Hon. Secretaries, and until such are received by them, Members remain liable for their subscriptions.

15.—The power of expulsion of a Member from the Society for objectionable conduct shall be vested in a General Meeting of the Society, provided the Council has caused special notice to be given on the circular convening the Meeting, and that two-thirds of those present and voting agree thereto.

16.—The Council shall arrange all Lectures, Papers, Demonstrations and Exhibitions of Specimens, etc., both for the General and Sectional Meetings of the Society, and shall decide upon all General and Sectional Excursions.

Sections

17.—The Council shall have power to form any Section or Sub-Section, to consist of not less than six Members, for the study of any special subject which the Council may deem within the scope of the Society's work. They shall annually appoint the Chairman of any such Section or Sub-Section on the nomination of that Section or Sub-Section.

A Section shall consist of those Members who attend in each year not less than three meetings of such Section.

The Chairman of each Section shall appoint a Secretary, who in addition to the ordinary secretarial duties shall keep a list of the Members of the Section.

Sectional Meetings.

18.—Each Sectional Chairman shall be responsible for the preparation and arrangement of each Sectional Meeting and Excursion, and shall submit details of the same to the Hon. Secretary for submission to the next ensuing Meeting of the Council. He shall submit accounts of costs incurred by him to the Hon. Treasurer, after each Meeting or Excursion, who shall lay the same before the Council at their next ensuing Meeting. At the first Meeting of each Section or Sub-Section in the Year, after the Annual Meeting, such Section or Sub-Section shall nominate its Chairman.

19.—A book for each Section shall be provided by the Secretaries to be kept at the Society's Room; each Chairman of Section, or his Secretary shall enter therein an account of each Meeting, with number of Members attending, and notes of any matters of interest observed or discussed. Such book to be presented at each Meeting of the Council. Every Chairman of Section shall report at each Meeting of the Council. Every Chairman of Section shall report as to the work of his section at the Annual Meeting of the Society.

20.—Any Members of the Council other than Ex-officio Members who shall have failed to attend half the Meetings of the Council held in any one year, provided that such non-attendance be not caused by illness or absence abroad, shall not be eligible for re-election, except by desire of the Members present at the Annual Meeting.

The President

21.—The President need not necessarily be selected from Members of the Society, and shall be elected annually. He shall deliver an Address at as early a date in the Winter Session as can be arranged.

Vice-Presidents

22.—Any Member of the Society who, in the opinion of the Council, shall have rendered distinguished service to Science or to the Society, shall be eligible for election as a Vice-President at the Annual Meeting, as long as he or she remains a Member of the Society.

23.—Each of the Vice-Presidents in rotation shall be requested to act as Chairman at the General Meetings of the Society.

Secretaries

24.—The Secretaries shall perform all the usual secretarial work; shall keep minutes of all Council Meetings, and the Annual Meeting, and a synopsis of all General Meetings. They shall cause a programme of each General Meeting to be sent to every Member seven days at least before each such Meeting. They shall make all preparations for carrying out all General Meetings and General Excursions, at which they shall receive from each Member his or her share of the day's expenses, and therefrom defray all costs of the Meeting. Any surplus of such collection shall go to the General Fund, and any deficit be defrayed out of that fund. They shall keep an account of all out-of-pocket expenses incurred in arranging Meetings and otherwise. They shall give notice of their election to all new members, they shall furnish a copy of the Annual Report to all Members who have paid their subscription, to Honorary Members, and to any such Scientific Societies as the Council may from time to time appoint to receive them.

25.—The Honorary Treasurer shall have the custody of the General Funds of the Society. He shall prepare a Financial Statement at the end of each Financial Year to be presented to the Council at the Meeting next preceding the Annual Meeting. He shall receive and acknowledge all Subscriptions, and shall issue tickets of Membership to all persons who are duly elected and have paid their Subscriptions. He shall bring before the Council any accounts that are due for payment. After presentation of the Balance Sheet to the Council, he shall submit it to the Auditors and lastly to the Annual Meeting of the Society. Treasurer

26.—At the Annual Meeting and at all General Meetings of the Society, not less than ten Members shall form a quorum.

27.—At the Annual Meeting, which shall be held in the month of October, the President, the Executive Officers (except the Chairman and Deputy Chairman of the Council), the Hon. Librarian, Hon. Editor, twelve Members of Council and two Auditors for the ensuing year shall be elected (either Auditor having the power to audit the accounts in the unavoidable absence of the other). At this Meeting the Council's Report of the past year, together with those of the Chairmen of Sections, and the Hon. Treasurer's statement of accounts, duly signed by the Auditors, shall be submitted. Annual Meeting

28.—Alteration in the Rules shall be sanctioned by a majority of not less than two-thirds of the Members present and voting at the Annual Meeting, or at a Special Meeting called for that purpose, and no alterations shall otherwise be made.

29.—Notice convening an Annual or Special Meeting, together with any proposed alterations in the Rules, shall be given to Members at least seven clear days before such Meeting be held. Notice of General Meetings, and Council Meetings (if possible) shall be given at least seven clear days beforehand.

30.—On a written requisition, signed by at least five Members of the Society, the Council shall call a Special Meeting to consider any question as to the affairs of the Society, such Meeting to be called within three weeks of the receipt of the requisition, and at least seven days' notice shall be given to the Members. At such Meeting no other business than that mentioned on the requisition, and on the notice convening such Meeting, shall be considered.



Report of the Inaugural Meeting of the Session 1914-15, AND THE Presidential Address

Delivered November 14th, 1915, by

SIR DANIEL MORRIS, K.C.M.G., J.P., M.A., D.Sc., D.C.L., F.L.S.

THIS meeting was held at Holy Trinity Hall. Sir Daniel Morris was accorded a reception, the warmth of which showed that his acceptance of the Presidency for a second year was much appreciated by the members of the Society. The address began with a review of the activities of the Society during the past year. Sir Daniel reported that there had been an increase of ninety in the membership, viz., from 426 to 516, and a cash balance of £52 17s. 2d. brought over to the current year. The outstanding feature of the year was the Congress of the South-Eastern Union of Scientific Societies, which met in Bournemouth from June 10th to 13th. The meeting was described in the "South-Eastern Naturalist" as "one of the most successful and enjoyable of the series of congressional meetings to which scientific societies in this part of England look forward. Regret was expressed on all sides that the proceedings could not have been prolonged, so that the appetite for the beauties of Bournemouth and for scientific lore which had been aroused by the lavish presentation of intellectual and aesthetic fare might have been appeased." As it was, visitors left in a hungry condition, but full of intention to re-visit at the first opportunity this exceptionally situated and most beautiful of seaside resorts.

As the war is practically the all-absorbing topic of our daily life just now, it may not be inappropriate (added Sir Daniel) if I devote the concluding portion of my address to some features of it regarded from the scientific or quasi-scientific point of view.

First, then, what are the aims and ambitions of our chief enemy, Germany, and what are the essential differences between the German and the Anglo-Saxon ways of regarding the world?

Sir William Ramsay, K.C.B., F.R.S., the eminent chemist and discoverer of Argon and Helium, has dealt very ably with these questions in "Nature" of October 8th last. Sir William considers that the most conspicuous features in the Anglo-Saxon character are respect for the rights of others and a spirit of fair-dealing. Oppression is alien to the genius of the race, its watch-words are equity, truth and justice, and, on the whole, the nation has acted up to its convictions.

We are taking part in the present war rather than see treaties broken and a small nation coerced into immoral acts by a

large and powerful one. We believe our cause to be righteous, and are prepared to support it to the death.

The German view of a nation's duties is very different and irreconcilable with ours. For us the State is but ourselves in a special aspect. If we do not like the policy of our representatives we change them. For the German race the State is an external, self-elected body. Its power is absolute; it determines what is best to be done, and its Army enforces its decisions. The Anglo-Saxon motto may be conceived as "live and let live"; the Teutonic command is "live as the State would have you live."

It cannot be denied that Germany has contributed much in the past to literature, to science, and to the art of music. Individual Germans have attained the highest eminence and have gained universal admiration. But originality has never, in spite of certain brilliant exceptions, been characteristic of the German race; their *métier* has been rather the exploitation of the inventions and discoveries of others; and in this they are conspicuous. The same obedience to command, and the same attention to detail, may be noticed in their industrial and scientific work as in their Army. Of recent years, according to common report, commercial morality among the Germans has been at a low ebb. They are disliked as business men; their methods are not regarded as fair, or their word as trustworthy. Even in the world of science this spirit is by no means unknown. In spite of their boasted progress in what they imagine to be civilisation, they have been relapsing into barbarism. And the execrable deeds of their Army—murder of defenceless non-combatants, destruction of priceless buildings, heartless cruelty to women and children—all these are merely the outward and visible sign of their spiritual beliefs. The aim of science is the acquisition of knowledge of the unknown; while the aim of applied science is the bettering of the lot of the human race.

The conclusion we arrive at is that this war is a war of humanity against inhumanity, of principle against expediency, of right against wrong. Fortunately, however, the present aspect of the war is favourable to the Allies, and justice and mercy will undoubtedly triumph. The question arises: If the Germans are wholly defeated as we hope, will the progress of science be thereby retarded? Sir William Ramsay thinks not. He asserts that the "greatest advances in scientific thought have not been made by members of the German race, nor have the earlier applications of science had Germany for their origin. So far as we can see at present the restriction of the Teutons will relieve the world from a deluge of mediocrity. Much of their previous reputation has been due to Hebrews resident among them, and we may safely trust that race to persist in vitality and intellectual activity."

Sir William Ramsay concludes: "It cannot be contended that the present war has in any sense been promoted by the

imagined spread of education and science in Germany. It affords to all men a lesson, however, that the moral sense of a nation requires educating, as well as the intellect; that a regard for truth and for the sanctity of a promise are more important possessions than a knowledge of recent discoveries and inventions; and that the intellectual progress of a country is to be measured by the intelligent participation of every citizen in the moral and mental conditions of the race."

Passing to other phases of the war, among the wonders of the modern world we may certainly include wireless telegraphy, the telephone, the motor, the aeroplane, the submarine, antiseptics and antitoxins, and the X-rays. All these are extensively in use in the war, and they are profoundly influencing the results. Wireless telegraphy, the aeroplane and the submarine may now be recognised as indispensable agencies in a successful campaign, while the use of antiseptics and antitoxins should contribute very largely to alleviate the sufferings of the wounded and to prevent the loss of thousands of valuable lives. In some campaigns, and notably in the South African War, it is stated that many more lives were lost through disease than in actual fighting. With proper precautions, typhoid fever, that devastator of armies, need no longer be feared if anti-typhoid vaccine is universally used. While the service of science appears to make war more deadly in some aspects, it also provides many palliatives whereby some of the worse horrors of war may be greatly reduced.

This war is remarkable for its silence. The Allies have worked together so harmoniously for a common cause that they have completely lost sight of their peculiar national interests for the sake of the common victory. President Poincaré used a happy phrase recently when he spoke of the "glorious anonymity" of the courage shown by the Allied forces and the grandeur of the collective soul in which are merged all the hopes of the combatants. All personal ambitions are sunk in the spirit of brotherhood in which the French and all the Allied Armies are waging this war. There is a great difference between our temperament and the French, but we understand each other now through all that difference and the barrier of language. As regards the British troops, their splendid courage and endurance have conclusively proved that there is no decadence in valour and fortitude, and they have shown against overwhelming odds great heroism and maintained the best traditions of the Anglo-Saxon race. In the present war anything less like Napoleon's way of making war it would be difficult to imagine. For this the aeroplane is largely responsible. It sees everything from its elevated vantage point. It sees troops on the march or being transported in trains, it notes the number of Army Corps, the proportion of the different arms, and all the details of the vast machine of war. In fact, to use a familiar phrase, it is like playing bridge with your opponent looking over your shoulder. Thus has science

changed war. As the "Times" states, it is now a "scientific" war—German made—as opposed to the "artistic" war of Napoleon, and General Joffre may be said to have become a master of the new system which he did not invent.

A cordial vote of thanks to the President for his interesting address was proposed by Mr. Claude Lyon, seconded by Dr. Moorhead, and carried by acclamation.



Report of General Summer Excursions, 1915.

Highcliffe Castle.

The first of the Summer General Excursions took place on Saturday, May 29th.

It was conducted by the President, Sir Daniel Morris, K.C.M.G., J.P., and the party, consisting of about 120 members, was very graciously received by the Hon. Mrs. Stuart Wortley and her daughter.

The first house was built by John, the third Earl of Bute, who was for a short period Prime Minister in the reign of George III. He took a keen interest in Botany, and died in 1792, a victim to his favourite pursuit by falling down the cliff near Christchurch to secure a new plant, believed to have been a purple Stock (*Matthiola*). Associated with him in scientific work at Kew was a remarkable man, Sir John Hill, the great-grandfather of Dr. S. McCalmont Hill, ex-Mayor of Bournemouth. The first house does not exist; its site, owing to the erosion of the coast, is said by the present owner to be about two miles out at sea. Lord Stuart de Rothesay, a grandson of the Earl of Bute, when Ambassador at Paris, purchased material from the Mayor's house at Les Andeleys on the Seine, including the exquisite traceried stonework and the beautiful oriel window, transported them by water to Highcliffe, and incorporated them in the present house. The famous Louisa, Marchioness of Waterford, succeeded her father, Lord Stuart de Rothesay, and the present owner, General the Hon. Stuart Wortley, came into possession in 1891. Among the objects of interest in the house are two fine pieces of tapestry, looted by Napoleon from the palace of the Knights of Malta; a well preserved copy of the Bible, dated 1639; the Mahdi's Flag, captured at Omdurman; a carpet which had belonged to Marshall Ney, bearing the initial N and his baton, and two chairs of Napoleon I. with a receptacle for snuff in the arms. In the grounds are many fine trees, including a tall Scots Fir, 90ft. high, a group consisting of the Turkey, scarlet, and common oak, numerous evergreen oaks forming a fine avenue, and a well grown Monterey Pine (*Pinus insignis*).

Cranborne Manor.

On Thursday, June 17th, by permission of Lord Salisbury, an excursion was made to Cranborne Manor House. Over 90 members and friends took part, under the leadership of the Rev. Hy. Shaen Solly, M.A., chairman of the Archæological Section. Owing to difficulties with the cars, part of the programme had to be omitted. By permission of Mr. H. E. Monro, of Edmondsham House, Castle Hill was first visited. There are three theories of the origin of this earthwork.

The first is that of the Rev. W. Barnes, who believed it to have the form of a "Cor" or ring, used, like other Celtic rings for the transaction of Bardic law. The second is that of Dr. Wake Smart, who refers it to Saxon workmanship. The third is that of Mr. Heywood Sumner, who considers Castle Hill to have been a Norman stronghold, an example of the "Motte and Bailey" Castle, with inner keep, the Motte, and outer courtyard, the Bailey, all surrounded by a ditch and bank. Dwelling amid a hostile Saxon peasantry, the Norman Baron wished to defend his inner tower against his retainers and others admitted to the outer courtyard, whereas in a Saxon fortified place the walls were planned to protect the whole community. It is possible that there is truth in all three theories, and that the plan was first a Celtic and afterwards a Saxon fortification and subsequently altered to suit the requirements of a Norman Baron.

The Abbey of Cranborne was founded in 980 A.D. Of the Norman church, the site of the original Saxon building, nothing remains except the doorway arch, a fine specimen of Norman work. The footings of the pillars are possibly those which supported the Norman columns; they are considerably larger than is required for the pillars of the present church, which dates from 1252 and is a noble example of Early English architecture. The tower dates from 1420. A most interesting oak pulpit carved out of a single trunk bears the initials T.P., those of Thomas Parker, Abbot of Tewkesbury, 1398-1421. This pulpit has survived the restoration of 1855 when much of archæological interest was destroyed.

At the time of the Domesday Survey the Manor of Cranborne belonged to Maud, wife of William the Conqueror; it passed to his nephew, who founded the Abbey of Tewkesbury. The "Forest" of Cranborne was a royal hunting ground, not subject to ordinary law, but under special regulations made by the King. When the King parted with these special privileges it became a "Chase"; it was of very wide extent and was a great resort of poachers. It was not till 1828 that the Chase came finally under ordinary jurisdiction. One of the places where offences against the game laws were tried was the Larmer Tree at Rushmore. Another was the noble hall of the Manor House at Cranborne.

There was a Norman house where King John stayed at least 14 times for the sake of the hunting; it was replaced by the present building early in the 16th century, and here King James 1st often came, and he granted the Manor to Robert Cecil, Earl of Salisbury, in whose family it remains. Queen Elizabeth's hunting saddle and two figures, representing Justice and Mercy, or, as some think, Peace and Plenty, are among the noted features of the place. The Jacobean Loggias, designed by Inigo Jones, are the best features of the external architecture.

Crichel House and Gardens.

By the kind permission of Lord Alington, a visit was paid on Tuesday, July 27th, to Crichel Park, in which 88 members took part. They were received by Lady Alington, who courteously conducted them through the principal rooms.

The decorations were carried out by Cipriani, an Italian artist, about 150 years ago. The walls of the dining room have designs painted on canvas in the centre of the panels, giving the appearance of high relief on a Wedgwood blue ground. The party then inspected the church. This is situated near the house and lake; the latter is bordered on one side by a dense mass of fine trees.

A tessellated Roman pavement was also seen, which had been taken from a Roman villa at Hemsworth on Lord Alington's property. It had been taken up in sections in plaster of Paris to preserve the small pieces of mosaic, and stored in a small building; the centre portion, forming a disc of about $2\frac{1}{2}$ feet in diameter, which had been carefully fitted together, represented a head believed by some to be that of Jupiter Tonans, and by others that of Septimius Severus, Emperor of Rome. This pavement is one of two found at Hemsworth; the other is known as the "Venus" pavement, and is now in the British Museum. An account of it is printed in Vol. 1 of the Society's Proceedings, pages 63 and 64.

It will interest the members of this Society to know that Mr. Hy. Le Jeune was mainly instrumental in having these pavements uncovered and saved from destruction seven or eight years ago.

The party was then taken through the grounds by the head gardener, and Mr. Hy. Backhouse, F.R.H.S. pointed out some of the numerous trees of particular interest. Among many others were a Himalayan Cedar (*Cedrus Deodora*), probably one of the tallest in England, and a young specimen of *Cedrus Atlantica*, of a very glaucous colour, planted by the Kaiser on his last visit to England and likely to make a noble tree in due time. A Judas tree of unusual size, bearing a profusion of seed pods, had evidently been covered with flowers earlier in the year.

Perhaps the most striking and interesting tree was a magnificent specimen of the American Swamp Cypress (*Taxodium distichum*), the intense brilliancy of its deciduous green leaves making a fine contrast with the cedars and pines close by; usually this tree attains its largest dimensions when growing in or near water, but this example was on the lawn, far from the lake.

Before leaving, a visit was paid to the White Farm.

Wimborne St. Giles and Knowlton.

The last General Excursion of the season was made on September 2nd by nearly 70 members, to Wimborne St. Giles, the seat of the Earl of Shaftesbury, and to Knowlton.

Arriving shortly after noon they were met by the Rector, the Rev. J. A. Bouquet, who showed the Church of St. Giles. It had

been burnt down in 1908 and rebuilt in 1910. A conspicuous object was the tomb, under a handsome canopy, and the effigies of Sir Anthony Ashley and his wife, and the kneeling figure of their only daughter and sole heiress.

After seeing a very fine Tulip tree in the Rectory garden, and an ancient yew tree, about 22ft. in girth, in the Churchyard, the party had lunch near the lake, where are some good examples of the Oriental Plane. The chief Arboreal feature of the Park was the noble avenue of Beeches, about three-quarters of a mile in length. The remarkable shell grotto was another object of interest. It was composed chiefly of some hundreds of thousands of Indian shells, arranged in a most artistic manner about 150 years ago by the fifth Earl and Countess.

Knowlton. The Rev. Hy. Shaen Solly, M.A., gave a short address on the old 14th Century Church, now a ruin covered with ivy, and the earthworks. The Church was a Chapel of Ease for Horton parish, with which it was always connected. He then described the origin and significance of the earthworks as representing a spot connected with pre-historic worship. The fosse (ditch) is inside the vallum (rampart), and such an arrangement is never made for defence, but is found where the place is a temple, and, it may be, also a cemetery. Both Chartres Cathedral and St. Paul's, London, were built on ground dedicated to a heathen deity, and at Le Mans the cathedral was built on the site of a stone circle. Such circles, with the ditch inside the rampart, are found in Dorset, Wilts, Cumberland and Westmoreland, and vary in size from 50 paces to that of the great circle at Avebury, 400 yards across, and the great cathedral of the race that built it. At Knowlton there were originally four circles, the one surrounding the Church remaining nearly perfect. A short distance south of this are three Round barrows, accurately in line, and this line, prolonged, passes through an opening in a vallum running east and west, and then through the centre of our circle. Thus there are five points indicating a definite orientation. This is N. 26 degrees E., and is the same as that of three other stone circles at Roll-rich, Oxon.; Stripples Stones, Cornwall; and Long Meg, Cumberland. Sir Norman Lockyer considers this was arranged to watch the rising of a star which would give warning of the approaching sun-rise. The direction is also exactly at right angles to the older orientation of Stonehenge, which may be a further indication of a connection with solar worship. The accuracy of the Knowlton line had been kindly verified that afternoon by Mr. Le Jeune. Mr. Solly then spoke of the importance to pre-historic man of the influence of the sun and the seasons. From Yuletide to Midsummer the sun continued to rise further and further to the north, culminating about 40 degrees N. of E., when the reverse process began. The summer and winter solstices were the occasion of

two great festivals. Magic ritual would attempt to secure life, fecundity in this world and a future life in another world. A stone pillar stood at the centre of the circle, and round it went the ritual processions. The direction taken would be with the sun—the Deasil turn—if the object was to invoke a plentiful harvest, while the reverse direction, called Tuaphol, would be taken in order to curse an enemy's crops.

Mr. Heywood Sumner, F.S.A., who had kindly come over to meet the Society, was asked to speak. He emphasised the connection between the Rings and Disk barrows, and wished the main purpose of the Rings and the meaning of the direction of the line through the barrows and the centre of the Ring to be carried to a suspense account till more had been learned from excavation. In the neighbourhood were several cases of barrows in line, the direction being N.W. and S.E., N. and W. and E. and W. A line of round barrows might also represent a rank, not a file.

After tea at Horton Inn the party drove back to Bournemouth.



Notes on the Sections and their Work.

DURING the year 1914-15 there have been certain changes in connection with the sections; of these the most noteworthy are as follows:—In the Archæological and Historical Section the Rev. H. Shaen Solly, M.A., succeeded the Rev. Canon T. E. Usherwood in the Chairmanship. Mr. Richard Beck, F.E.S., and Mr. R. Y. Banks, became Chairmen of the Entomological and Photographic Sections respectively. Mr. W. Munn Rankin, M.Sc., B.Sc., left the chair of the Zoological and Microscopical Section to occupy that of the Geological Section, Mr. T. B. Goodall, F.R.C.V.S., F.L.S., being his successor in the former position. It is a matter of regret that Mr. Beck has found it necessary to retire after a short tenure of his office.

Archæological and Historical Section.

CHAIRMAN: THE REV. H. SHAEN SOLLY, M.A.
SECRETARY: H. J. ELLIS.

Since I had the honour of being elected Chairman of the Archæological and Historical Section we have held the usual monthly meetings, full particulars of which are given in the Council's report. Our thanks are due to friends who have given us food for thought which may relieve the tension of mind which we are all now feeling. We have also been able to co-operate in the work of the General Excursions which so often present features which come within the scope of our Section, and it has been a pleasure to take part in the arrangements which have been so admirably planned for the Society by its Hon. Secretary.

H. SHAEN SOLLY.

Botanical Section.

CHAIRMAN: MISS C. AGNES ROOPER.
SECRETARY: MR. R. V. SHERRING, F.L.S.

The Botanical Section has had a most satisfactory year, and its success is chiefly due to the unwearied toil and energetic action of Mr. Sherring, our indefatigable Honorary Secretary, assisted by Mr. Green, to whom our thanks are due for his invaluable help. Many new and rare plants have been added to the list of the flora of Bournemouth and its district. The curious *Spartina* grass has been thoroughly examined and worked up by Mr. Sherring, whose

report on it is appended. During the Winter session interesting lectures on various Botanical subjects were given by expert authorities, to whom the thanks of the section are due.

On Saturday mornings in each week, September to April inclusive, a few of the members met in the Society's room to arrange the Herbarium. For this work special thanks are due to Mr. Swain, who on his own account also devoted many hours in each week to it, and has brought it to a most successful issue. Thanks are also due to Miss Jeffery, who has most unfailingly and punctually been present each Saturday morning to aid in the mounting of the specimens and other work.

The Section has sustained a great loss during the year by the death of its kind and valued friend, Dr. Shillitoe.

Various gifts of specimens of plants have been added to the collection, which has now become quite an important one. Books have also been presented to the Section from time to time.

Such in brief is the record of the Botanical Section. Besides Mr. Sherring's report on *Spartina*, a list of plants collected by him and Mr. Green will be found below.

C. AGNES ROOPER.

REPORT ON *SPARTINA* GRASS*

BY

R. V. SHERRING, F.L.S.

1913-14.

I have to offer special thanks to Captain Marston for permission that enabled me to visit and carefully examine the luxuriant growth of this grass in places closed to the public.

HOLES BAY.—Here the increase continues. Another of these gregarious patches of little grass islands is forming off the North shore, south of the Poole-Weymouth line and midway across the bay between Creekmore Lake on the east and Upton Lake on the west. North of the line the increase continues, and at Hamworthy Bridge, Poole, the grass is much thicker.

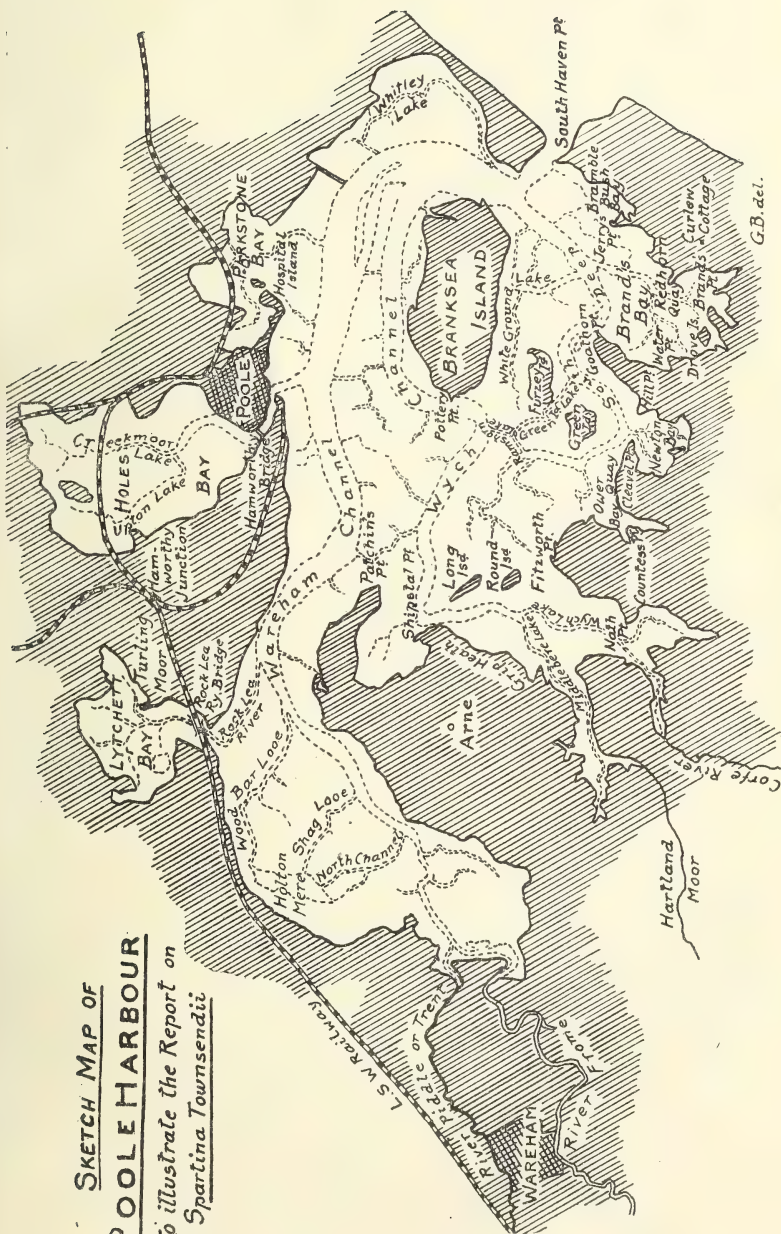
POOLE HARBOUR.—Off the Sanitary Hospital there is a very considerable change, the clumps being much larger and spreading over more ground, with a tendency to become meadows. On the approach to the mouth of the harbour the growth of the grass is suspended or far less rapid. A small patch of clumps is forming

* First record, H. & J. Groves, 1878, "Journal of Botany, xi. i., 1882; with plate, *S. stricta*, var H. & J. Groves, "Journal of Botany," viii. 277; Townsend's Cord Grass"" Townsend's Flora of Hants," 1904, page 479; "Gardeners' Chronicle," vol. xliii, Third series, 1908, page 33; "Tansley: Types of British Vegetation," 1911, page 337; "Proceedings of the Bournemouth Natural Science Society," vol. iv., page 49, 2 plates, also vol. v., page 48, R. V. Sherring, F.L.S.; page 76, Dr. Stapf, F.R.S., 4 plates.

SKETCH MAP OF

POOLE HARBOUR

To illustrate the Report on
Spartina Townsendii





a little to the right of where the Canford Cliffs' road strikes the Haven Road at Whitly Lake, but here they are still very slow in increasing. On crossing to the South Haven and walking to Bramble Bush Bay and Jerry's Point the increase is found to be only slight, but to become more marked to the west. From Red Horne Quay to Brands Point the increase is considerable and the clumps larger. In the Whitly Lake there is an increase and clumps are forming into groups. From Drovers Island to Water Point a tendency to meadow is noticeable, and from thence to Goathorn Point there is much more grass formed.

FITZWORTH POINT AND WYCH CREEK, LONG AND ROUND ISLAND DISTRICT.—This is the headquarters of the *Spartina*, and affords the finest near view of the grass in the harbour. Northwards the bands are thicker, observations being made at both high and low water.

From Fitzworth past Nath Point to the foot-bridges there is one vast meadow, rolling away like fields of corn with the sheen of golden brown that can be seen shining miles away. Such an appearance was first noticed as a distinctive character of the growth by me, and not by Dr. Stapf, as previously mentioned in error.

Beyond Round and Long Island to Arne shore the colour and sheen is also seen in the distance, and at sunset it is sometimes gorgeous.

From Fitzworth and Nath Point to the foot-bridges the increase in the meadows and the general luxuriant growth is very marked, and it is really here that the rapid increase and future reclaiming of land can be conceived. Mr. C. B. Green and myself surveyed it both at high and at low water, which should be done to follow its ways of increase. The farmer speaks of the great liking the cows have for the grass, and that they will go into the mud after it, but it is reported not to be good for the milk.

WAREHAM CHANNEL.—In my last report I mentioned that the grass had not spread far up this channel and Middlebere. This is not the case now as regards the former. In the Rock Lea Railway district there is an all-the-way round increase. Higher up the channel at Holton Mere are signs of a considerable beginning of growth. If a line be drawn from Keyworth Point to Rock Lea Railway Bridge the advance of the grass to the south in the direction of Arne shore is considerably greater.

Over the whole district under observation there is a moderate increase in the growth.

1914 - 15.

TURLING MOOR.—Starting from Hamworthy Junction, Turling Moor is first examined, where a considerable thickening of the clumps is observed, also an increase to the westward is noticeable in Lytchett Bay.

HOLES BAY.—Following the shore there is a moderate extension and solidity of the clumps, and, on approaching Hamworthy Bridge, a tendency to “meadowing.” Crossing the bridge and proceeding to

HOSPITAL ISLAND, the clumps are seen to be markedly larger and many have joined together, giving an insular appearance as seen from the railway.

PARKSTONE BAY.—Here the addition has been gradual, but at Whitley Lake the few clumps have only slightly increased. Proceeding to

SOUTH HAVEN, and on to Bramble Bush Bay, it is found that at this point the clumps have slightly increased in size, but not in number. At Jerry’s Point there is a considerable increase.

BRAND’S BAY.—Rounding Redhorn Quay the grass, running parallel with the shore, has steadily extended to the south and in the centre of the bay. Onward from this point a great change has occurred to the westward and north-west towards Goathorn East shore. In this area the increase is marvellous. Viewed from Water Point the grass appears as one vast thick meadow stretching in every direction and surrounding Drove Island. To the north the bands off the shore of Branksea Island are far more prominent than before. Surveyed in one mass the sight is the most striking in the Harbour, but it is inferior in acreage to the mass seen from Fitzworth Point.

GOATHORN POINT.—Looking from the Pier to Branksea Castle a large belt of grass is seen stretching from Furzey Island round to nearly opposite Curlew Cottage, broken naturally by the White Ground Lake and South Deep. From here it appears one continuous band with a channel to the north. A heavy belt follows the shore to Hill Point, opposite which is Cleavel Point, a few hundred yards away. To the south of these points is Newton Bay, a large circular space, and here much increase has occurred and the mud is thickly covered.

OWER BAY.—From Countess Point and up the creek to the westward “meadowing” is going on.

FITZWORTH POINT.—Being high water at the time of inspection, the grass was not seen to the same advantage as last year, but in this, the largest area of *Spartina* to be seen from one point, there is very extensive progress, notably between Round and Long Islands and on to Grip Heath shore, Shipstal Point, Arne Bay and Patchin’s Point. To understand this vast area of grass it is desirable to consult the accompanying map of Poole Harbour, noting the various places named and especially the three main channels—the Wareham and Wych Channels, running to the north of Branksea Island and joining east of it, and the South Deep, draining the southern shore east and south of the Wych Channel. I now proceed to the distribution of the grass in this area, of special interest as it was in this neighbourhood that it was first noticed.

ARNE BAY.—Here the grass is fairly heavily distributed. The mud between Grip Heath and Wych Creek is meadowing and also between Middlebere Lake and the upper part of Wych Lake. This triangle of mud is richly meadowed.

Eastward are Round and Long Islands, between which the grass has meadowed. The short distance between the south of Round Island and Fitzworth Point is considerably covered on both shores. Eastward of these islands and between the tributaries of the South Deep heavy bands of grass are year by year increasing. Now, what is the problem of the future, supposing the grass increases to the same extent as it has between the last named islands? The South Deep will then have only one source of supply by channel to the eastward, namely, the channel called Ramshorn Lake. This district affords the most interesting study of the grass in the harbour.

MIDDLEBERE AND ARNE.—The grass has now reached the head of the first named creek and there are a fair number of patches from the saltings to Middlebere Quay. Onward along Grip Heath shore a considerable band of grass extends right up to Shipstal Point; opposite to this is Patchin's Point and between these lies Arne Bay, which is thickly covered, making an extensive meadow of grass. From Patchin's Point a heavy band runs southward to the edge of Wych Creek. The vast triangle of grass between Middlebere Creek and the Corfe River is well seen from this side as well as the gradually silting up channel between Long and Round Islands, and, in a less degree, the change at Fitzworth Shore.

NORTH SHORE AND WAREHAM INLET.—Looking across from Keyworth Point to Rock Lea Railway Bridge (under which runs the Rock Lea River, joining the Wareham Channel off the Lake Clay Works) are to be seen three draining channels. Furthest east is Wood Bar Looe, nearer is Shag Looe, while the nearest and westernmost is North Channel, all draining from Horton Lake. Off this last channel is a considerable band of grass spreading from the North Shore to nearly off Keyworth Point and terminating in five insular clumps. A little to the west are the last clumps I have met with, forming the western limit of the grass in the harbour. Eastward towards Rock Lea Bridge are two large insular patches, much increased in extent, beyond the Rock Lea band, where this year the grass has so developed that the effect of the growth in this part is shown by the raising of the level of the mud sufficiently to allow cattle to cross to it for grazing on the grass, as was seen by members of the Botanical Section on their summer visit. Here was well shown the golden brown sheen of the ripe *Spartina* in the sunset and a similar pleasant brightness is said to be visible in the early morning. Apparently the higher waters of Wareham Channel are now the only place in the harbour not invaded by *Spartina Townsendii*, so that in about sixteen years the grass has dominated the harbour, causing a general rise

on the muddy grounds; whilst to a great extent other salt-loving plants mentioned in previous reports are springing up in the shallower parts and will help to bind the mud into more solid grass land.

LIST OF BRITISH PLANTS FOR THE DISTRICT.

Collected by R. V. Sherring, F.L.S., and C. B. Green, during 1915. L.C. Ed. 10.

- 67 *Corydalis claviculata*, D.C.—G. & S.
- 129 *Erysimum orientale*, Mill.—G.
- 432 *Prunus Padus*, L.—G. & S.
- 574 *Agrimonia odorata*, Mill.—G. (new stations).
- *Scorzonera humilis*, L.—G. (June 5th), see "J. of B," October, 1915.
- 721 *Carum verticillatum*, Koch.—G. & S. See "J. of B," November, 1914.
- 1307 *Utricularia intermedia*, Hayne (in flower).—S.
- 1390 *Chenopodium polyspermum*, L.—G.
- 1418 *Salicornia radicans*, Sm.—G.
- 1420 *Suaeda fruticosa*, Forsk.—G. & S. (new stations).
- 1561 *Orchis latifolia*, L. forma.
(*O. praetermissa*, Druce), S. & G. See "J. of B." June, 1915.
- 1731 *Eleocharis acicularis*, Roem & Schult.—G.
- 1761 *Carex dioica*, L.—S. & G. (new stations).
- 1799 *C. limosa*, L.—G. & S. (new stations).
- 1809 *C. pallescens*, L.—G. & S.
- 1831 *C. inflata*, Huds., X *vesicaria*.—G. & S.
- 1835 *Panicum Crus-galli*, L.—G.
- 1836 *Setaria viridis*, Beauv.—G.
- 1837 *S. glauca*, Beauv.—G.
- *Hordeum jubatum*, L.
- 1870 *Calamagrostis epigeios*, Roth.—G. (several new stations).
- 2008 *Lastrea montana*, T. Moore.—G. & S. (new stations).
- 2032 *Equisetum limosum*, L. var. *verticillatum*, Doell.—S.
- 2072 *Nitella translucens*, Agardh.—I. M. Roper.
- *Puccinia Thesii*, Chaill. (on *Thesium humifusum*), D.C.—S. & G.
- *Septoria, Euonymi-japonicæ* (on *Euonymus* leaves).—G. New to Britain

Entomological Section.

CHAIRMAN · RICHARD BECK, F.E.S.

SECRETARY: W. OMER COOPER.

The Chairman of the Section having resigned, the Hon. Sec. reports that besides Mr. Neale's lecture, which appears on a later page, there were two Exhibitions of Insects by members and two excursions for the purpose of collecting insects.

Geographical Section.

CHAIRMAN: GEO. DE CASTRO, M.R.C.S.Eng., &c.

SECRETARY: W. J. WOODHOUSE, A.C.P.

The meetings and excursions of the Section have been limited in number, the members having had more important calls upon their time, but are duly noted in the Council's report. There is nothing of special interest to be added. G. de C.

Geological Section.

CHAIRMAN : W. MUNN RANKIN, M.Sc., B.Sc.

Partly by force of circumstances, though largely by design, the excursions taken by this Section formed a closely related group so that in the course of five Saturday afternoons such members as attended obtained an ordered knowledge of the succession of strata from the Middle Bagshots as seen at Canford Cliffs to the Barton Sands of the Chewton Cliffs. It may be safely affirmed that this measure of intensive examination of a limited succession had a definite educational value.

W.M.R.

Photographical Section.

CHAIRMAN : R. Y. BANKS.

SECRETARY : EDWIN DODSHON, LL.B.

The Section works in conjunction with all the others, but during the season it has carried out two independent excursions, one to Creech Grange and the other to Bingham's Melcombe. Record work has now been put on a practical basis and a fair start made. It only waits for further contributions of subjects of interest included in the area covered by the map in the "Natural History of Bournemouth."

R.Y.B.

Physical Section.

CHAIRMAN : HUBERT PAINTER, B.Sc., F.C.S.

SECRETARY : E. W. BARLOW, B.Sc., F.R.A.S.

There is nothing of special interest to add to the list of meetings given in the Council's Report.

H.P.

Zoological Section.

CHAIRMAN : T. B. GOODALL, F.R.C.V.S., F.L.S.

SECRETARY : J. OMER COOPER.

There were two lectures given in this Section by Mr. Rankin and one by Mr. W. Omer Cooper. The last is reported on a later page and is followed by a list of local Wood-lice.

No excursions were arranged.

A Selection from the Papers read before the Society.

Some Isle of Purbeck Plants.

By C. B. GREEN.

(Read before the Botanical Section, Part I., December 9th, 1914 ;
Part II., February 4th, 1915.

I.—DICOTYLEDONES.

The Isle of Purbeck is situated in East Dorset and is bounded on three sides by water, viz., The Channel, Swanage and Studland Bays, and Poole Harbour; while on the fourth, or Western side, a small stream known as Luckford Lake, rises near East Lulworth and loses its individuality near West Holme, where it debouches into the river Frome and then into Poole Harbour. Such a district, with its varied strata and many levels, its great chalk range and its limestone hills, must have a peculiar interest to the botanist as well as to the geologist. This, I hope, will duly appear as I proceed.

Perhaps I ought first to say that my connection with the district only dates from 1911—the year of the great drought. As I had been for some time interested in gardening and botany, I embraced the earliest opportunity of acquiring the two principal works on the local flora, viz., the *Flora of Dorset* (1895), and the *Flora of Bournemouth* (1900). As the latter includes the former—for all practical purposes—and is more up-to-date, I propose to take this, in conjunction with the recent review in the Society's Handbook by the same authority, as my *vade mecum*. While the History of Purbeck has been well told in that publication, there are still a few things that may be said—a few plants that may be recorded for our particular section.

Although the Isle of Purbeck contains extraordinary physical features, I think it will be as well to deal with the flora in natural sequence on account of the limited area, rather than to split it up into groups or associations.

Thus I will begin with Ranunculaceæ, always premising that I intend—with few exceptions—only to take notice of new, rare or uncommon plants, and to indicate fresh habitats or stations.

Adonis annua, L., the Pheasant's Eye, is a very beautiful plant, with finely cut leaves and bright scarlet flowers, and is well placed in the Buttercup order. It is not common anywhere, and therefore to have it in some quantity in Purbeck, between Seacombe and St. Aldhelm's Head, is a pleasant feature. Although it is not supposed to be a native, it has established itself on the

Seacombe cliffs. *Myosurus minimus*, L., the little mousetail, is a plant I have looked for many times, but without success until this year—1914—when Mr. R. V. Sherring, F.L.S., indicated its locality, and now it is also mine.

As to the Buttercups proper, especially the water forms, they are admittedly difficult, so I will surmount those difficulties by ignoring them altogether. There are, however, one or two other forms more or less rare; one of these is *Ranunculus Sardous*, Crantz., the hairy one. I have only seen this twice in Purbeck, while the Great Spearwort has, so far, eluded me altogether. The next member of the order of profound interest is *Helleborus foetidus*, L., the Stinking Hellebore, because it is new to our district. It flourishes on the great chalk Downs near Creech Barrow, although I have not yet been able to obtain flowers therefrom. A transplanted root, however, has flowered in very fine style. The *Delphinium*, or Larkspur (*D. Ajacis*, L.), a doubtful native, is not often seen, but Studland has contributed one to the flora. The beautiful White Waterlily may still be found in its recorded habitats; while the Yellow one is hardly more frequent, if I may judge from my notes on the subject. The Poppies come and go, and while in one year they may be plentiful, in another the more inconstant forms are conspicuous by their absence. I possess all those recorded. As to *Fumaria*, they are much misunderstood, but I have a few passable specimens collected in the presence of Mr. H. W. Pugsley, B.A., the authority on this genus, from whom I have imbibed much information. He is a keen botanist and knows his plants well, and it is therefore an education to be associated with him.

Next comes the Cruciferous tribe, and although many of them are weedy-looking subjects, there are some worthy of being noted here. *Cardamine pratensis*, L., or Ladies' smock is, of course, common, but the double form is not so, although I can claim two records for it. *Brassica oleracea*, L., the Wild Cabbage, is locally abundant from the Old Harry Rocks to St. Aldhelm's Head. Otherwise it is rare. *Diplotaxis tenuifolia*, D.C., and *D. muralis*, D.C., the wall and sand Rockets respectively, both find a home in Swanage. As far as I know they have no other habitat. On the other hand the Sea-Rocket (*Cakile maritima*, Scop.) has deserted our shore, but may be picked up about Studland and South Haven. There is one other I must notice because it finds no place in the *Bournemouth Flora*, viz., *Lepidium Draba*, L., one of the Pepperworts, which in due season makes a fine show here, and although it is an alien we are not particularly anxious for its internment. As to violets we are exceedingly well off, and I have collected some which have surprised even our great specialist, Mrs. Gregory, who writes:—"Dear Mr. Green, whatever the critics may say we must, I think, still further split the Violets." That is very gratifying testimony to an amateur. I wish, therefore, I could find time to go more fully into these beautiful spring flowers, but I must hasten on, otherwise I shall

never be able to get to the end of this review. Another rare and local plant is *Silene nutans*, L., the Nottingham Catchfly. Doubtless it has often wagged its caryophyllaceous head unseen at those who pass by steamboat under the Old Harry cliffs. It is a pretty plant, and many there are who would like to possess it, but—there is a risk about it!

Of the *Hypericums*, *H. dubium*, Leers, is certainly rare, and new to our district, while *Geranium lucidum*, L., is very local. Of leguminous plants we have several interesting species, notably *Lotus hispidus*, Desf., *L. tenuis*, W. and K., *Vicia gracilis*, Lois., *V. sylvatica*, L., *Lathyrus nissolia*, L., and *L. sylvestris*, L., the everlasting Pea—an unfortunate adjective. The genus *Rosa* (which always calls up sweet associations) must be passed over, and likewise the critical Rubi, except in respect of *Spiraea salicifolia*, L., which is new to Purbeck; *Agrimonia odorata*, Mill, in two fresh places; *Pyrus Aria*, Ehrh., for which I have a new station, and *P. communis*, L., the wild pear, recorded for Arne, but which, as the Rev. E. F. Linton, M.A., F.L.S., will hear with regret, has now ceased to exist. Of *Chrysosplenium oppositifolium*, L., the Golden Saxifrage, I can quote two additional habitats; while *Sedum album*, L., the White Stonecrop, may also be extended. *S. reflexum*, L., although only given for Swanage, has many other stations. From walls to bogs may not be a long way, but the vegetation is entirely different. Thus we are brought into contact with the Sundews, and, by association, with the great naturalist, Chas. Darwin. Of the three species, two are well represented, while the third, *Drosera anglica*, Huds., is exceedingly rare, and perhaps, in consequence, ought to be considered with reservation. However, its Purbeck habitat is now known to me through Mr. Sherring—I cannot go further, for he and I have some strong ideas concerning vandalism. Outside Purbeck my diligence has been rewarded, but, at present, I have not divulged the secret to him! There are many things I must ignore, not because they are uninteresting, but because I must curtail somewhere. The Umbelliferous Order, for instance, with two exceptions—the Sea-Holly (*Eryngium maritimum*, L.) which does not now exist in its old habitats, but has favoured me with a new one; and *Carum verticillatum*, Koch. (allied to the Corn-Parsley), which is a delightful acquisition, and to think that this should have been discovered in our little “Isle” and not by me, is deeply to be deplored. However, as the finder is a namesake of mine it almost looks like a family affair! For a full account of this new Dorset plant, the *Journal of Botany* for November, 1914, may be consulted.

We must now pass rapidly along to the *Compositae*, and even in this group our observations must be brief. I will just note two stations for the white form of the Hemp Agrimony (*Eupatorium cannabinum*, L.), and one each for a double and a proliferous form of the Daisy, before we come to the Elecampane (*Inula Helenium*, L.), which is of the Sunflower order. One station only is given

for this, whereas I can produce six. In connection with the Golden Samphire (*I. crithmoides*, L.), I may say that to one who is not afraid to rush in "where angels fear to tread," it may be found all along our dangerous coast from Tilly Whim to Chapman's Pool. The lovely Yellow Ox-eye or Corn Marigold (*Chrysanthemum segetum*, L.), though not so common as in the Wareham district, may be found with us in some quantity. In 1912 we had a field of it in full bloom in December! The little rayless *Matricaria suaveolens*, Buch. (*discoidea*, D.C.), a native of North America, once so rare, has now become in many places a veritable weed. *Artemisia maritima*, L., the Sea Wormwood, with its silvery, much-divided foliage and refreshing scent, still flourishes on that sandy spit of land near Arne. *Petasites ovatus*, Hill, the Common Butter-bur, is not common with us; while its sweet-scented sister, *P. fragans*, Presl., usually regarded as rare, is with us in quantity. Thus "common" and "rare" are simply relative terms. *Senecio Jacobaea*, L., the Ragwort, was a glorious sight last year (1913) on Ballard Down; so much so, in fact, that persons who usually take no notice of such phenomena could not help remarking it. With Thistles we are well equipped, but what is known as the Slender-Headed Thistle (*Carduus pycnocephalus*, L.) appears with us to be the variety *tenuiflorus* Curt. only. I think I have the species from Beer Head, in Devonshire. In the Musk Thistle (*C. nutans*, L.) we have perfume as well as beauty; its *white* form has come to me on two occasions; and so has *C. crispus*, L., and, I think, *C.c.-X nutans*. The great Woolly-Headed one (*Cnicus eriophorus*, Roth.) seems to be rare in other districts, whereas in rough places on our oolitic formation it is usually in fine trim. *C. palustris*, Willd., and *C. pratensis*, Willd., are both common, but *C. Forsteri*, Sm., a cross between them, I have only seen once, in a Creech Grange meadow. To get a *white* form of the black Knapweed (*Centaurea nigra*, L.), is not outrageous, any more than a *red* one of the blue Corn-flower (*C. cyanus*, L.), for what appears to be an apparent contradiction in terms is entirely due to what is called popular phraseology. The *Hieraciums*, another difficult genus, are not for me, so I will eschew further reference to the Compositae. On the Heathlands what is more beautiful than *Erica ciliaris*, L., the far-famed Dorset Heath? I have even found an albino form of this, as I have of *Tetralix cinerea*, and *Calluna vulgaris*; but the rarest of these is *E. Watsoni*, Benth., a cross between *ciliaris* and *Tetralix*, which last year preceded the parents in point of flowering. It may be discovered between Stoborough and Arne, also on Wytch Heath. While on the subject of *E. ciliaris* I think it is worth recording that locally it has the very appropriate name of "Foxglove Heath."

There are some other genera which will conjure up pleasing recollections, but they can only be mentioned—Primroses, Pimpernels, Periwinkles. Of Gentians the finest of all our blues is *G. Pneumonanthe*, L., and this year it seemed to be unusually fine,

both in form and colour. Even a pure *white* one must be recorded. The precocious, or early-flowering one, which is, or was, supposed to be a variety of *G. amarella*, L., was in fine form last season as early as April, not only in its recorded habitat, but also in some quantity on Ballard Down.

There are many interesting subjects in the *Labiatae*, such as the aromatic Mints and the sweet wild Thymes. Before touching on these I must mention the re-discovery, at Langton, of *Linaria repens*, Mill., and its hybrid with *L. vulgaris*. All three plants were growing together. As to the mints, as they hybridise freely, they are necessarily somewhat difficult to determine, and when this happens an amateur botanist cannot be quite sure of his ground. Fortunately I have been able to refer mine to a trusty friend, who is an old Kew man. *Mentha rotundifolia*, Huds., is, however, a good species, and is reported from Corfe Castle; but although I have failed to find it there, I think I have a better, because a more natural, habitat near Chapman's Pool. *M. spicata*, L., is well known in connection with gardens and mint sauce, while *M. crispa*, Hook., is a cross between these two. Although the hybrid plant is not mentioned for Purbeck, I have excellent specimens from waste land at Swanage. Apropos of this unfortunate station I may add that our contingent of Kitchener's Army has now trampled this out of existence. *M. gentilis*, L., another rare Mint, is also at Swanage, but will doubtless meet the same fate, as the necessities of the situation imply the tramp of many feet! *M. arvensis*, L. is fairly common, but has so many varieties that one cannot always distinguish between them.

That well-known and favourite little plant, the sweet Wild Thyme (*Thymus serpyllum*, L.) must be specially mentioned here, not only because it abounds here, but because some forms of it have been supplied to my friend, Mr. A. Bruce Jackson, for illustration in the new *Cambridge Flora*.

Another plant I am particularly pleased about is *Calamintha Acinos*, Clairv., the Basil Thyme, which I here put on record for Purbeck, and which was the result of simple analogical reasoning. A day or two previously I had tried for this plant *outside* the Isle, but without success, and thus my find became additionally interesting.

Nepeta Cataria, L., otherwise known as Catmint, is rather rare. This may be due to those ferocious and blood-thirsty felines, as Gilbert White calls them, which prowl the hedge-rows for rabbits, etc., and which, when they are satiated with a flesh diet, turn aside and "go for" the plant in question. At any rate, I must admit that till some years ago I was sceptical on this point, so I transplanted a wild root to the garden. At first there was no response, but later, when it was scented out, attacks were made until the whole plant had been exterminated! Whether Linnaeus, the great father of botany, who gave it this name, knew of the peculiar Cat-affection for it, history does not relate.

The two little Skullcaps (*Scutellaria galericulata*, L., and *S. minor*, Huds.), are fairly plentiful, but the *intermediate* form does not seem to have been noticed here. I have, however, two localities for it. Here I may mention another hybrid between *Stachys palustris*, L., and *S. sylvatica*, L., which does not find a place in our Flora. Happily here also the deficiency can be supplied. *Galeopsis angustifolia*, Ehrh., the narrow-leaved Hemp-nettle, though not recorded for Swanage, has persisted here for several years in some profusion. *Ballota nigra*, L., the Black Horehound, and *Ajuga reptans*, L., the little Bugle, have both yielded me their albino representatives.

The *Chenopods* or Goosefoots—an awkward term to pluralise—are not generally much sought after. But here again one called *Chenopodium hybridum*, L., is deserving of notice; while *Atriplex laciniata*, L., one of the Oraches, is most interesting, because although recorded for N. and S. Haven, its very existence is questioned, and is considered “an old record not confirmed of late.” Here again I am able to state that I have collected the plant in *both* the above stations and also for Studland shore. *Chenopodium polyspermum*, L., has also turned up. The *Salicornias*, or Glassworts, are troublesome things, but at least one notable form, *S. disarticulata*, Dr. Moss, has a station at S. Haven, and has been identified by the author. But for my friend, Mr. H. W. Pugsley, B.A., I should have overlooked it. *S. radicans*, Sm., another rare plant, has recently furnished me with two habitats. Another unrecorded plant for this locality is the Sea-Blite (*Suaeda fruticosa*, Forsk.), and so it would appear that this sandy, barren-looking spit of land opposite the N. Haven is really most inviting. This plant also cropped up at Goathorn. A new record for *Polygonum Bistorta*, L., the Bistort or Snake-weed, was indicated recently in a Corfe Castle meadow, at one of our excursions: while another Corfe Castle rarity is the Mistletoe. The rare Spurge (*Euphorbia portlandica*, L.), is doubtfully given as “abundant, Gadcliff”; but as I have seen it there in quantity it may be taken as a fact. The other rare Sea-spurge (*E. Paralias*, L.) well known for the Chesil Beach, has actually been discovered at Studland on the sand dunes by Mr. Ed. Belcher, an artist-botanist, with whom I have had several pleasant rambles. In fact we had only just said “good-bye” when he ran across it, so the honour is entirely his.

II.—(A) MONOCOTYLEDONES.

In pursuance of my remarks on the Purbeck Flora, I may say that we have now come to quite another class of plants. Probably the Orchids are the most interesting, certainly the most curious and beautiful. With Orchis proper we are well supplied, *O. ustulata*, L., being rare. Even this turned up last year in its old station, but was unfortunately, though inadvertently, appropriated by the finder. A “new” species, however, or rather one that has been long overlooked, *O. praetermissa*, Druce, has

afforded Mr. Sherring and myself much food for reflection. For some years this plant has been noticed by us, and, while I have a specimen from a Studland bog, dated 1909, and labelled *O. incarnata*, L., *forma*, for want of a better name, Mr. Sherring has, I believe, an earlier record from the same locality. However, it is now evident that Mr. Druce has also noticed some distinctions between this plant and *O. latifolia*, L. and *O. incarnata*, L. (with which it is closely allied), and, with his usual acumen, has caught these specific differences and given us a new name. For full description see "Journal of Botany" for June, 1915. Fortunately Purbeck is well represented in this matter, for several localities have been observed, and Mr. Druce has been good enough to verify specimens sent up. *Malaxis paludosa*, Sw., the Bog Orchis, an unique little gem in its way, has one or two stations with us, but I cannot discover them at present. However, I have been most fortunate in finding another, and, although eight plants were then apparent, I have not been able to locate them again. There is, I think, something very erratic about these Orchidaceous plants, for while they are much in evidence in some seasons, in others they are entirely wanting.

Cephalanthera grandiflora, Gray, the White Helleborine, is a giant compared with the last. Its specific name implies that, and, moreover, it adopts a different habitat, being a woodland plant on chalk or limestone. I have it on the latter. Hitherto unrecorded for Purbeck. *Epipactis latifolia*, All., is another Helleborine, and also affects woodland. It is known for Creech Grange Wood, and has lately been found at Swanage! Its sister, *E. palustris*, Crantz., still flourishes here. We also have:—

The Butterfly, both small and great,

The Spider and the Fly;

The Frog, and Fragrant Orchis, too,

And Bee abundantly.

Why *Crocus vernus*, All., should be omitted from the *Bournemouth Flora* I am at a loss to understand, as there are huge quantities at Studland, as many of our members can gloriously testify. Of Irises, *Iris foetidissima*, L., the Stinking Gladwin, or Roast-beef plant, is quite a characteristic Isle of Purbeck subject, but why "roast beef" should be appended to it is somewhat difficult of definition, as when the plant is bruised it emits a *disagreeable* odour. Its flowers are of a dull purplish hue, whereas in the variety *citrina*, Bromf.—which has several stations here—the flowers are of a clear lemon-yellow. A root of this variety has been transferred to Major Van de Weyer's garden at Smedmore House, as he is desirous of effecting a cross between this and a foreign species. To lovers of our native flora this garden is unique, for it contains many forms of wild flowers more or less abnormal; and it is very gratifying to a Britisher to know that while exotics are freely cultivated here our home-bred flora is also much in evidence. Another plant of great beauty is the wild Daffodil, and

here again we are fortunate in its possession. *Narcissus biflorus*, Curtis, too, is also here, and, although like the last, is considered doubtfully native, in one of its habitats it has the appearance of being quite at home. *Galanthus nivalis*, L., the common Snow-drop, whether an escape or otherwise, is a welcome addition to the harbingers of spring. We now come to some Liliaceous plants—a charming group. *Convallaria majalis*, L., or Lily-of-the-Valley, is quite naturalised in the Creech Grange glades, as is also *Colchicum autumnale*, L., in the meadows. Then we have *Ornithogalum umbellatum*, L., the Star of Bethlehem, in our Swanage pastures, and also at Encombe; while *Tulipa sylvestris*, L., the wild Tulip, has been known for generations at Smedmore. With the “Flowering Rush” (*Butomus umbellatus*, L.)—as if other rushes did not flower!—we must conclude what may be termed the popular flora. To me, however, there is another Rush, viz., *Juncus tenuis*, Willd., which, although outside Purbeck, has come my way as a county record! Who shall say, then, that rushes are not interesting? The Cyperaceae must be our next consideration—the great family of Sedges and Carices. *Cyperus longus*, L., I am happy to report, is still doing well; while *Eleocharis acicularis*, R. Br., the little Club-rush, has turned up in two places. On the other hand, I regret to say that *Scirpus parvulus*, R. and S., the tiny mud-rush, has eluded all our efforts lately; but *S. sylvaticus*, L., may now be added to our list. *Cladium mariscus*, Br., although an “outsider,” must be touched on here, as I have had the good luck to find it where the Rev. E. F. Linton failed to do so, and the late Mr. Mansel Pleydell believed it to be extinct! The Carices—which might be dilated on—will only receive scant notice. *Carex dioica*, L., which has hitherto puzzled me, has this year—1915—turned up in great abundance in four different places! It is a bog plant, and wet feet usually accompanied these finds, as Mr. Sherring can faithfully testify. I also wish to associate his name with *C. limosa*, L., for we have now two stations for the Isle of Purbeck. *C. strigosa*, Huds., is another good find; and *C. pallescens*, L., just survives in Creech Grange Wood; while *C. helodes*, Link., has given us another habitat. Much more might be said about these plants, for at least forty species and varieties have been “vasculumed” this season. The Grasses, too, have given very good results. *Panicum Crus-galli*, L., *P. miliaceum*, L., *Setaria viridis*, Beauv., *S. glauca*, Beauv., *Phalaris canariensis*, L., and *Anthoxanthum aristatum*, Boiss., have all been taken. *Polypogon monspeliensis*, Desf., and its hybrid with *Agrostis alba*, L., which is very rare, have also turned up; while *Calamagrostis epigeios*, Roth., has occurred abundantly in four places! *Gastridium lendigerum*, Gaud., *Deschampsia setacea*, Rich., *Holcus mollis*, L., *Cynodon Dactylon*, Pers., *Briza minor*, L., and even *B. maxima*, L. (on waste ground); *Poa nemoralis*, L., and *P. compressa*, L., *Glyceria distans*, Wahl., and *G. rupestris*, E. S. Marshall (*Festuca procumbens*, Kunth.), *Lepturus filiformis*, Trin., *Nardus stricta*, L., *Hordeum jubatum*, L., a rare alien, and many more which, of necessity, I refrain from mentioning, have been

found. *Elymus arenarius*, L., however, must be noted as absent from the flora in 1900, whereas now, at South Haven, there is quite a little colony. *Spartina Townsendii*, H. & J. Groves, at that date, was given as "very rare!" However, Mr. Sherring's photographs are now eloquent testimony to the contrary.

II. (B) FUNGI.

When the Rev. E. F. Linton, M.A., F.L.S., was preparing an account of the Fungi of East Dorset for the proceedings of the Dorset Natural History Field Club, a suggestion reached me through Mr. R. V. Sherring, F.L.S., that I should contribute to this paper my observations in the south of the district. I, therefore, submit to you a list which is representative only of the Fungus-Flora of Purbeck. The fungi mentioned therein were collected by me during the past season—1914-15—and identified, for the most part, by Mr. J. F. Rayner, F.R.H.S., without whose aid this presentation would have been impossible. With a view to the curtailment of space, authorities and descriptions have been omitted, as these are fully dealt with by Mr. Rayner in his admirable and exhaustive paper on "The Fungi of the New Forest," Proceedings B.N.S.S., Vol. III., p. 105.

A Tentative List of Fungi for the Isle of Purbeck.

Class I.—Basidiomycetes.

Family I.—Agaricacæ ("Gill Fungi").

- Amanita phalloides*. Woodland near Scotland Farm; Pine Wood North of Corfe Castle, and other places.
A. mappa. Goathorn Wood.
A. muscaria. As above; Arne Wood; Encombe Wood.
A. rubescens. Pine Wood, North of Corfe Castle; and many other places.
Lepiota procera. ("Parasol Mushroom.") Frequent on the Downs. Highly commended for the table.
L. excoriata. Grassy places on the "Saltings," Arne; plentifully.
L. cristata. Rempstone; Norden Plantations.
L. holosericea. Nine Barrow Downs.
Armillaria mellea. Studland; abundant in one place.
A. mucida. ("Beach Fungus.") Creech Grange; Rempstone Wood.
Tricholoma rutilans. Pine Wood North of Corfe Castle.
T. terreum. Kingston Woods; under Quince Hill Wood; grassy roadsides and plantations, Durlston, Swanage. This, and its variety *argyraceum*, abundant in the latter station.
T. gambosum. (St. George's Mushroom.") Nine Barrow Downs in several places; meadow by Leeson Wood. Esculent, and much esteemed by some.
T. personatum. Many places on the Downs and meadows of Purbeck. Edible; sold under the name of "Blewitts."
T. nudum. Pine Wood, Bushey; plantations, Durlston.
T. grammopodium. Sandy meadow, Bushey.
T. sordidum. Meadow by Quince Hill Wood; Herston; Durlston, and above the quarries, Swanage.
T. paedidum. Peveril Downs; the quarries, Swanage.
Clitocybe nebularis. Nine Barrow Downs; Chapman's Pool Downs. Abundant and fine.
C. odora. Norden Plantations.

- C. rivulosa*. Downs, Chapman's Pool.
C. infundibuliformis. Quince Hill Wood; Woodhouse Wood; Durlston.
C. inversa. Norden Plantation.
C. flaccida. Pine Wood, Bushey.
C. cyathiformis. Above Whitecliff Farm, Swanage.
C. fragrans. Quince Hill Wood, Langton.
Laccaria laccata. Godlingstone Heath; Pine Wood North of Corfe Castle.
L. l. var. amethystina. Latter station; Rempstone; Norden.
Collybia radicata. Kingston Woods; Rempstone; Arne.
C. maculata. In many places.
C. butyracea. Wood, Corfe Castle; Wood near Scotland Farm; Creech Heath; Godlingstone Heath; Durlston.
C. velutipes. On stump North side of Nine Barrow Downs.
Mycena pura. Norden Plantations.
Mycena tintinnabulum. On fallen Bramble twigs, New Swanage.
Omphalia rustica. Sandy field beyond the boundary, at present.
Hygrophorus virgineus. Nine Barrow Downs; Pine Wood, Rempstone.
H. niveus. Ballard Down; Corfe Common; Golf Links, Swanage.
H. coccineus. Corfe Common; Nine Barrow Downs; Swanage, etc.
H. miniatus. Corfe Common; Nine Barrow Downs; Swanage, etc.
H. puniceus. Corfe Common.
H. obrusseus. Corfe Castle; Kingston Woods.
H. conicus. Creech Heath; Rempstone; Studland.
H. chlorophanus. Nine Barrow Downs.
H. psittacinus. Golf Links.
Lactarius torminosus. Norden Plantations.
L. insulsus. Studland.
L. blennius. Studland.
L. vellereus. Langton; Rempstone; Corfe Castle; Arne.
L. deliciosus. Fitzworth Heath; near Corfe Castle.
L. thejogalus. Pine Wood near Corfe Castle.
L. rufus. Pine Wood near Corfe Castle; near Scotland Farm; Norden.
L. serifulus. Pine Wood, Bushey; Rempstone.
Russula nigricans. Studland.
R. densifolia. Quince Hill Wood.
R. ochracea. Norden Plantations. "Scarce."
R. caerulea. Woodhouse Wood; Corfe Castle; Swanage.
R. drimeia. Under Pines. Common.
R. vesca. Rempstone.
R. emetica. Norden Plantations.
R. ochroleuca. Goathorn Wood; Rempstone.
R. fragilis. Quince Hill Wood; Goathorn; Rempstone.
R. veterinosa. Quince Hill Wood; Goathorn; Rempstone.
Cantharellus cibarius. Rempstone.
C. aurantiacus. Nine Barrow Downs; Norden; Rempstone.
Marasmius peronatus. Norden Wood; Rempstone.
M. oreades. ("Champignon," or "Fairy-ring Mushroom.") Common; edible; delicious.
M. ramealis. On twigs; Kingswood. Very pretty.
Volvaria bombycina. On Black Poplar, near Wareham. Rare.
Entoloma clypeatum. Newton, Swanage.
E. cericeum. Corfe Common; Nine Barrow Downs; pastures, Swanage.
Nolanea pascua. Ower Heath; Nine Barrow Downs; Windmill Knap, Swanage.
Pholiota aegerita. On Ash, near Swanage.
P. squarrosus. On Ash, near Chapman's Pool.
P. spectabilis. On Apple tree, Langton.
Inocybe rimosa. Kingston Wood.
Hebeloma fastibile. Pine Wood, Bushey.
Galera tenera. Pastures and woods. Common.
G. hypnorum. Ower Heath.

- Tubaria furfuracea*. Luckford Copse; Durlston; Swanage.
Crepidotus mollis. On deal Ash, Encombe.
Cortinarius hinnuleus. Pine Wood, Corfe Castle.
C. caninus. Creech Meadows.
C. anomalus. Nine Barrow Downs.
C. cinnabarinus. Norden Plantations.
C. cinnamomeus var. *semi-sanguineus*. Norden Plantations.
Paxillus involutus. Pine Woods. Frequent.
Agaricus arvensis. ("Horse Mushroom.") Pastures and Downs; but NOT so common as the next.
A. campestris. ("Common Mushroom.") Abundant in the "Isle." Needs no "bush." Var *silvicola*. Kingston Wood; Norden Plantations.
Stropharia aeruginosa. Nine Barrow Downs.
S. merdaria. Corfe Common; Nine Barrow Downs.
S. semiglobata. Creech Heath. These species are fairly common.
Hypholoma fasciculare. Common on stumps, etc.
Psilocybe ericaea. Studland Heath.
P. foenisecii. Nine Barrow Downs.
Bolbitis fragilis. On dung, Nine Barrow Downs.
Coprinus comatus. ("Lawyer's Wig.") Ulwell; Swanage; and other places, especially road-sides and waste ground.
C. atramentarius. Churchyard, Swanage. These two are said to be "delicious" !
C. fimetarius. Studland.
C. micaceus. Encombe Downs; Kingston Woods; Durlston Plantations.
C. deliquescens. Coombe; Ulwell.
C. domesticus. In the garden.
C. plicatilis. Goathorn; Swanage.
Panæolus phalænarum. Studland.
Psathyrella gracilis. "Gully-field," Herston.
P. atomata. Rough ground, Swanage.
P. disseminata. On wall, Swanage. Very pretty.
Gomphidius glutinosus. Fitzworth Heath; Rempstone.
G. viscidus. Studland; Stoborough; Norden.

Family II.—Polyporaceæ ("Pore Fungi").

- Boletus luteus*. Norden Wood.
B. flavus. Foxground Plantation, Rempstone; Norden.
B. æstivalis. Luckford Copse.
B. granulatus. Studland; Rempstone; Kingston; etc.
B. bovinus. Fitzworth; Scotland Heath; Goathorn; Swanage.
B. badius. Corfe Castle; Norden Plantations.
B. piperatus. Luckford Copse; Goathorn Wood.
B. variegatus. Fitzworth Heath; Norden Plantations.
B. chrysenteron. Norden Plantations.
B. edulus. Generally distributed. "One of the best."
B. laricinus. Norden Plantations.
B. scaber. Generally distributed.
Polyporus squamosus. On Poplar, near Corfe Castle; on Elm, Studland; on stump, Durlston.
P. dryadeus. On Oak Rempstone; West Holme.
P. hispidus. On Elm, Godlingstone; on Ash, Newton Manor; and in the Rectory garden, Swanage.
P. nidulans. On Oak branches, Talbot and Farm Woods.
P. betulinus. On Birch, Goathorn Wood. Rare in Purbeck.
P. adustus. Ballard Down; Durlston; Kingston Woods.
P. amorphus. Rempstone.
Fomes ulmaria. On Elms, Knitson, and Studland.
F. annosus. On stump, Durlston; Norden; Kingston.
F. applanatus. On stump, Durlston.

- Polystictus versicolor*. On stumps, common; Kingswood; Durlston; Swanage.
P. velutinus. On stump, Pine Wood, Rempstone.
P. abietinus. On Pine stumps, etc. Rather common.
Poria vaporaria. On dead branches; in many places.
Trametes gibbosa. On stump, Durlston; Kingston Woods; on *Salix* in wet wood near Scotland Farm. An unusual form.
Dædalea quercina. On Oak post, Knitson.

Family III. Hydnaceæ ("Hedgehog Fungi").

- Hydnum repandum*. Pine Wood, N. of Corfe Castle. Edible.

Family IV. Thelephoraceæ ("Leathery Fungi").

- Stereum hirsutum*. On post, Nine Barrow Downs.
S. purpureum. On post, Durlston; "abnormal," Corfe; Swanage.
S. rugosum. On stump, Pine Wood, N. of Corfe Castle.

Family V. Clavariaceæ ("Club and Coral Fungi").

- Sparassis crispa*. Pine Wood, Rempstone.
Clavaria fastigiata. Rough ground, Herston; Peveril Downs.
C. cristata. Goathorn Wood.
C. rugosa. Norden Plantations.

Family VI. Tremellaceæ ("Jelly Fungi").

- Auricularia lobata*. On Elm stumps, Knitson, and Swanage.
Hirnedala auricula-Judæ ("Jew's Ear"). On Elders, Kingston (two or three places); Durlston; Swanage. Very fine.
Tremella mesenterica. On Gorse stumps, in many places.

Family VII. Phalloidaceæ ("Stinkhorns").

- Phallus impudicus*. Godlingstone Heath; Norden Plantations.

Family VIII. Lycoperdaceæ ("Puff-balls").

- Geaster rufescens* ("Red Earth-Star"). Norden Plantations.
Lycoperdon perlatum. Pine Wood, Rempstone.
L. depressum. Downs and rough pastures; common.
L. celatum. Fitzworth Heath; Bushey; Nine Barrow Downs.
L. echinatum. Norden Plantations.
L. gemmatum. Norden Plantations; Studland.
L. pyriforme. Downs, Chapman's Pool; Peveril; Swanage.

Family IX. Sclerodermaceæ ("Earth-balls").

- Scleroderma vulgare* ("Devil's Snuff-box"). Common.

Family X. Hymenogastraceæ.

- Rhizopogon luteolus*. Goathorn Wood.

Class II.—Ascomycetes.

Family I. Pyrenomycetes ("Capsular Fungi").

- Diatrype* sp. (old), probably *disciformis*. On Beech branch (rotten), Rempstone.
Hypoxylon fuscum. On Hazel sticks, Quince Hill Wood; Farm Wood; Kingswood; and other places.
H. multifforme. Rempstone Wood.
Daldinia concentrica. On dead Ash; Foxground Plantation, Rempstone; Encombe Woods.
Xylaria hypoxylon. On stumps and posts in many places.
X. polymorpha. Kingston Woods.

Family II. Discomycetes.

Helvella crispa. Pine Woods, Rempstone; Norden. Edible.

Geopyxis coccinea ("Scarlet Cup-moss"). Rempstone.

Peziza vesiculosa. On manure in the garden; on road sweepings, Swanage.

P. leporina. Norden Plantations.

Otidea aurantia. Farm Wood, Langton; Station Yard, Swanage.

PARASITIC FUNGI.

In addition to above the following have also been observed :—

Melanotaenium endogenum. On *Galium verum*, rough pastures, Langton; Downs above Lighthouse, in some quantity; and about the quarries, Swanage. This is a *black* fungus, and usually spreads and destroys the plant before it can flower.

Puccinea Thesii. On *Thesium humifusum*, Downs above Lighthouse, in some quantity; also in the quarries, Swanage. ("Rust Fungus.")

Puccinea Malvacearum. On *Malva sylvestris*, Creech; Langton; Swanage. Gardeners know this as "Hollyhock Disease."

Trochila ilicis. On fallen Holly leaves, Creech, and Studland Woods.

Erysiphe (Oidium) Euonymi-japonicæ. *Euonymus* "Mildew." Much too frequent on these shrubs about Durlston and Swanage. For description and illustration *vide* Proceedings B.N.S.S., Vol. III., p. 81.

Septoria Euonymi-japonicæ ("Spot Fungus"). On fallen leaves of *Euonymus*, which is largely planted at Durlston. NEW TO BRITAIN. While, however, the preceding fungus is a summer state, this one matures during winter and spring. (See illustration and note by Mr. J. F. Rayner F.R.H.S.)

NOTE.—In preparing these papers for publication a good deal of matter has been excised, in fact the section dealing with the Ferns has been omitted altogether. On the other hand a few subsequent finds have been included.

Swanage, October, 1915.

C.B.G.

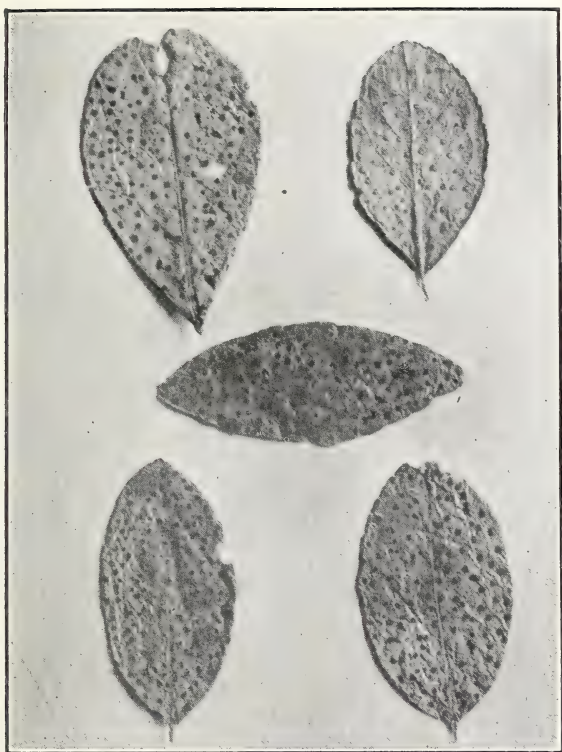
The Significance and Possible Origin of the Colour Pattern of the Puss Caterpillar.

JOSEPH NEALE, B.A., Bournemouth.

(Read before the Zoological Section, January 14th. 1915.)

STUDIES in outdoor rearing of Caterpillars in their natural habitats suggest that it may be of general interest to call attention to the correlation of posture and colouring to environment in the Puss and Kitten larvæ, and to enquire if there is any hint of how their peculiar pattern has originated.

The Puss, the largest and most striking of the group, will serve as type of all. Its pattern is apparently unstable—two specimens are seldom quite alike either in tone or distribution of colour—the same batch of eggs will produce larvæ with markings ranging from close approximation to Poplar and Sallow Kittens as figured by South, to the typical *Timula* patterns accu-



Septoria Euonymi-japonica, Passer.

This species, now for the first time added to the British fungus flora by Mr. Green's fortunate discovery, is a member of a large and somewhat miscellaneous aggregation of microscopic fungi now classed as Deuteromycetes or Imperfect Fungi. They are all suspected, and some have been proved, to be only forms or states of higher fungi. The section to which *Septoria Euonymi-japonica* belongs bears its spores in a flask-shaped vessel, the perithecium, but, unlike the great class Pyrenomycetes, which is also distinguished by the possession of this organ, the spores in *Septoria* and its allies are not enclosed in mother-cells or asci, but borne on more or less distinct stalks, like the agarics and other Basidiomycetes. The genus *Septoria* (Lat. *septum*, a wall or partition) is so called because the spores are many-celled. This new species is found, as the photograph indicates, as black, round or oval flattish pustules or discs, pretty evenly disposed on the dead, fallen leaves of the evergreen garden *Euonymus*.

J. F. RAYNER.

October, 1915.



ately mimicking leaf-form, and with the dorsal saddle ranging in colour from purple or purple-grey to cream.

(We have not taken the Kittens in sufficient quantity to learn if their pattern is variable).

In the full grown larvæ the mimetic effect of the colour scheme is heightened by the light border which separates the green from the purplish areas, the thin light line picking out the design in accurate mimicry of high lights caught by thin leaf edges, or by the edges of holes perforated in leaf tissue. This last effect is seen to perfection in larvæ which have the cusps of the dorsal pattern as they approach the ventral line detached from the main saddle, when the islands of purple, margined with white, irresistibly suggest holes in green with shadow coming through.

The Puss at maturity hanging as is its wont back downward from petiole or leaf edge presents in an oblique position when attached to its support at a high angle, the suggestion, when seen laterally as a passing bird might espy it, of two green leaves against a background of purple bark or shade—while in a horizontal position—which on the average of occurrences in the foliage of a large *Populus* must be the commonest posture—the dorsal saddle is an accurate copy of the slightly upturned tip of a fore-shortened leaf. So good is either resemblance that working men shown the full grown larvae at two feet distance failed to detect them, or recognise a caterpillar till convinced by the evidence of touch.

Whence has the light marginal line which lends all its significance to the pattern originated?

To answer this question we must consider the relative survival-value to the race of the growing larva at each moult. Suppose the Puss Moth to lay two hundred eggs—a modest estimate—to keep up the supply of the species, year by year, only two of these need complete the life cycle. Regarding the successive life stages as heats in a race, we have five heats, and if as is probable we may dismiss the pupal dangers as relatively negligible, we shall be well within the mark in estimating a loss of half the competitors in each heat. The survivors in the last heat have evidently a survival-value equal to that of the whole batch at hatching; they are diminished to one sixteenth of their original total and each individual has risen sixteen fold in survival-value—they are large and toothsome and urgently in need of concealment. The light line now so effective a detail of the colour scheme would be, if broad, a danger rather than an element of safety. This therefore precludes its earlier development. Can we hazard the conjecture that the ancestral puss caterpillar lived in its last stage, as its descendants still do in the four earlier moults, on the upper side of the leafage—that it was smaller, and that the wavy light line was then broader and in all the stages of functional value?

A leaf, seen from above as a passing bird would see it, if injured presents the following appearances:—

1. A mere scratch or mechanical lesion will give a pale mark

of dying etiolated tissue or a dark mark of dead tissue often with a light border.

2. Or such a scratch may cut the leaf, the hole seen from above showing black shadow with highly lighted border caught by the edge of the hole.

3. A round hole pierced in a leaf or a nibbled irregular lesion will present the same view from above.

But these appearances are accurately those of the growing puss larva seen from above. Its mimetic progress is somewhat thus:—

a. Newly-hatched—a black streak = a scratch on leaf.

b. Second stage—black with a little russet = a budscale fallen from a higher level and resting on a leaf.

c. Third and fourth stages—ground plan of a central irregular chocolate coloured area with a (functionally valueless) lighter border = a hole in leaf showing shadow through from below.

These stages, at least b and c, would be better mimetically if the light border had a real functional value, but the exigencies of the final stage have probably eliminated an originally broader pattern. May we suppose, speaking teleologically, that nature having perfected the pattern up to the fourth stage, suddenly went one better, altered her plan, gave up the light line in its earlier function, and used it, narrowed, to pick out a pattern accurately mimetic of leaf form as well as of generalised leaf colouring?

The correlation of pattern to environment can be justly appreciated only by rearing the larvae in the open *in situ* on the food plant, preferably on *Populus balsamifera*. All the stages but the last are lived on the upper side of the leaf—unlike the Poplar and Eyed Hawk Moths whose larvae are coloured with equal fitness for their sub-foliar habitat—the usual position in full view on mid-leaf being maintained by day, the larva feeding chiefly at night and returning to the same position of rest day after day—but in the final ecdysis the larva is pendulous, and hangs back downward from petiole or leaf-edge, frequently feeding continuously day and night, and escaping detection unless a tree be overstocked so as to increase the risk of discovery.

The Puss in its early stages is admirably hidden on the small-leaved species of *Salix*. Is it possible that it was once smaller and confined to the smaller-leaved Sallows? What advantage does it derive from being larger than the Kittens? Is it to bring the growing larva rapidly past the stage when it can be mastered by Ants? I have lost whole crops of minute larvae from the attacks of ants against which protective colouring probably avails little as they seem to hunt chiefly by touch.

The shiny triangular patch from the dorsal hump to the head of the Puss would be advantageous chiefly to larvae living on polished foliage—this area reflects grey diffused light very suggestive of shiny leafage, and in the inverted position a reflecting surface may be of use for concealment, as is the polished cuticle of *Pheosia tremula* which reflects the colour of its surroundings.

If the foregoing observations are correct the Puss and its immediate allies would seem to constitute a limited and well defined group of Moths whose larval development has reached a high stage of specialisation and whose habits of feeding and rest and the positions assumed at various stages of development show a very delicate and still evolving adaptation to its needs.

Azolla and Pilularia: two local Water Ferns.

By W. MUNN RANKIN, M.Sc., B.Sc.

Read before the Botanical Section, January 21st, 1915.

THE appearance in the early Spring of 1914 of a species of *Azolla* in Jumpers' Pond, near Iford Bridge, that well-frequented resort of microscopists, suggests an account of its distribution and structure as well as of the native water fern, *Pilularia*.

The Jumpers' Pond species is *Azolla filiculoides*. Another species, *A. caroliniana*, also occurs in Britain, but the two are readily distinguished by the fact that only *A. filiculoides* fruits here. I am indebted for much of my information on the distribution of these two species to a paper by A. S. Marsh in the "Journal of Botany," Vol. LII. (1914), b. pp. 209-213, and shall use it in the following notes on distribution.

Azolla is a tropical and warm temperate genus, spread over both hemispheres. Two of the five species have been introduced into Europe, and both have spread to our country: *A. caroliniana*, a species of the eastern border of America with a range from Ontario to Brazil, and *A. filiculoides*, which is confined to the western part of America, between California and Chile. *A. caroliniana* first appeared in Europe in 1872, when it was introduced to Continental botanical gardens, from which it soon spread into the neighbouring ditches and ponds and became a sort of pest. It was first recorded for England at Pinden (Middlesex) in 1883, and has since been recorded for other places in the South of England, though in some cases in error for the other species. It was not until Ostenfeld, of Copenhagen, while on tour with the other botanists of the International Phytogeographical Excursion of 1911, identified the *Azolla* of Woodbastwick (Norfolk) as *A. filiculoides*, that it was recognised that two species existed in Britain. *Azolla filiculoides* was purposely introduced into Europe in 1880 by Roze at Bordeaux, where he thought the marsh ditches were eminently suited for its growth. It rapidly spread on the Gironde and later in the rest of France. It reached Italy in 1900. The exact season of its first appearance in England is not yet determined, though it was distributed as *A. caroliniana* in 1910. It

occurs definitely in the Norfolk Broads, in Berks, and Gloucester. Its continued distribution throughout the south-eastern counties generally on suitable water may be fully expected.

The Jumper's Pond Azolla was first noticed in the spring of 1914 by Mr. A. J. Rainer. He is confident that it was not there in the previous year. Mr. J. Omer Cooper soon afterwards brought me a specimen which I identified as Azolla. During the summer of 1914 it completely covered the pond.

Pilularia globulifera, or Pillwort, from its pill-like "fruits," is generally distributed throughout England and Scotland, but is very rare in Ireland. It is fairly common and where found, luxuriantly so, in the New Forest on the muddy edges of streams and "plashes" by the road sides.

Azolla and *Pilularia* belong to a group of ferns which is characterised by an aquatic or amphibious habit and by heterospory. Otherwise they are widely different. In order the better to understand the intricate life history of these two ferns it will be wise to go over briefly the main features of the life history of an ordinary fern. For fuller treatment both of this and the story of Azolla and *Pilularia*, the student is recommended to read D. H. Campbell's "Mosses and Ferns" (Macmillan and Co.)

It will be known to all that on the back of the frond of a common fern like the Male fern or the Hart's Tongue are well defined areas where spores are formed. An examination with a hand lens shows a large number of stalked spore-cases; the *sporangia*, grouped beneath a membranous covering, the *indusium* and comprising the *sorus*. The spores are distributed by the wind and, falling on suitable soil, germinate and give rise to green flat heart-shaped structures, some one-third of an inch across at the widest, the fern-scales or *prothalli*. The sporangia, the spores and the prothalli are each all of one kind. The prothallus roots itself and grows. On it develop two different sexual organs: the *archegonia*, which contain the female egg, and the *antheridia* with the male motile sperm-cells. After fertilisation the egg develops into an ordinary fern plant as we know it, not into another fern-scale,—that is produced only from a spore falling from the back of a fern frond. There is thus a well marked *Alternation of Generations*: a fern plant, giving only spores, the *sporophyte*, and a fern scale or prothallus yielding sexual cells or gametes, the *gametophyte*. So much in brief for the ordinary Homosporous Fern. With the Azolla and *Pilularia* the case is different and much more obscure. Though there is superficially a resemblance in plan of reproduction between these two genera, the one typical of the *Salvinaceae* and the other of the *Marsiliaceae* they are in reality widely removed from one another and show no true alliance. They must, therefore, be considered apart.

The sporangia of Azolla are of two kinds, the *microsporangia*, with many small spores, the *microspores*, from which develop much reduced prothalli, upon which in turn are produced the male organs or antheridia and within these the sperms

or male gametes, and the *macrosporangia*, each bearing one large spore only, which develops into a prothallus on which in its turn develop the female archegonia with their contained egg, or female gamete.

The microsporangia are grouped in spherical indusial envelopes that are easily seen on the plants in late summer and autumn. The macrosporangial sorus is small and contains one sporangium only. The two sori are quite distinct and grow together on the apices of the submerged lower lobe of the lowest leaf of a branch. Both make interesting microscopic objects. To mention one feature only out of many. When mature the microspores within each sporangium are enclosed in separate masses of metamorphosed protoplasm, the *massulae*, and attached to these are numerous hooked hairs, the *glochidia*. In *A. filiculoides* the stalks of the glochidia are non-septate; in *A. caroliniana* they have 3-5 transverse walls. The massulae are set free by the decay of the sporangial wall and float out. The developing macrospore is similarly released, the projecting filaments of its wall being ready to catch on to the glochidia of a massula. Fertilisation of the egg in the mature archegonium follows on the surface of the water.

The sporangia of *Pilularia*, like those of *Azolla*, are of two kinds, but the resemblance does not go further. Here they are grouped first into sori and these again in groups of four to form with metamorphosed leaf segments the so-called "*sporocarps*"—globular bodies seen at the stem nodes. Within each sporocarp both kinds of sporangia occur, the micro- and macrosporangia. When ripe the sporocarp bursts at the apex and emits a mucilage carrying the spores already liberated from the two different kinds of sporangia. The germinating spores give rise almost entirely to the sex organs, the purely vegetative parts of the prothalli being represented by a few vestigial cells only. Fertilisation takes place and the embryo of the ordinary plant develops.

The vegetative structure of *Azolla* shows many interesting features. The plants float lightly on the surface of the water in dense tufts, with the ends of the shoots curved upwards a little. The leaves are numerous and closely set together, and consist of two nearly equal lobes; the upper, floating and emergent and the lower submersed. The upper lobe bears many unicellular hairs on its upper surface, which keep it from being wetted, and shows a large cavity near the base in which reside as a sort of "room-parasite" the blue-green alga *Anabaena*. The colour of the freshly grown leaves is bright green, but towards the end of the summer it becomes a brilliant red: the appearance of Jumper's Pond when completely covered by a blood-red sheet of *Azolla* at the end of the dry summer of 1914 was very striking. The olive green roots are well developed, numerous and fairly long. In the winter the mass of *Azolla* growing in the pond was flooded over upon the surrounding marshy border. Here the plants appeared to grow for a while on the damp surface after the water had retired, but failed to make

good their hold, for in the succeeding summer none were found away from the pond. It can hardly be competition with other plants that is the determining factor.

Pilularia, we have already seen, grows on soft mud that is rarely dried up in the course of the year and it often covers square yards to the total exclusion of all other plants. At first sight it looks like a species of grass, if it were not for the coiled ends of the leaves showing the circinate habit so characteristic of Ferns, and having dark green globular sporocarps on the creeping stems. The upright weakly erect leaves spring from the nodes and are very simple in structure. The stem is sharply divided into nodes and internodes; from the nodes spring both leaves and roots; the internodes are bare. The anatomy of both stem and root has many interesting features.

The two distinct families of Heterosporous Ferns, of which Azolla and Pilularia are the types, have the feature of great interest in representing an attempt in the course of the evolution of the Ferns to develop a successful line of heterospory. Similar attempts appear in other groups of the Pteridophytes; in the fossil Calamites amongst the Horse-Tails and in certain Lepidodendra amongst the Lycopods. Full success, if that may be measured by the setting up of a strong line which finally reached expression in the flowering plants was only gained by the extinct allies of the Ferns, the Cycado-filices among which were Lyginodendron, Bennetites, Williamsonia, etc., described in the present volume on pp. 67-69 in Dr. Scott's lecture on the Fore-runners of the Flowering Plants.

The Fore-runners of the Flowering Plants.

By DR. DUKINFIELD H. SCOTT, M.A., LL.D., F.R.S.,

Past President, Linnean Society; Foreign Secretary, Royal Society.

(Read before the Geological Section, January 27th, 1915.)

IN my Presidential Address to the Society on November 26th, 1910, I spoke of the "Seed Plants of the Coal," a section of the Palæozoic Flora. I am glad to hear that my friend, Sir Daniel Morris, is likely to be lecturing soon on the Eocene Plants of the Bournemouth Cliffs, of which he has been making a study for some time. The subject to-day relates to the Flora of an intermediate age—the Secondary or Mesozoic Period. Though not of such immediate local interest as the Tertiary Flora, the present subject comes much more within the range of a Hampshire Society than the Palæozoic forests, for some of the most important and classical specimens of the Secondary fore-runners of the Flowering Plants are found in the Isle of Wight and many others in the neighbouring counties of Dorset and Sussex.

The Mesozoic Flora preserved on the whole a very uniform general character from the Rhætic up to the Neocomian. But after the Lower Greensand there came a complete change, due to the successful usurpation by the true flowering plants. It is the earlier flora, in which the old families were still dominant, of which I propose to speak on the present occasion.

These old plant families of the Mesozoic age included Horse-tails, already much shorn of their Palæozoic glories, a few Club Mosses, still more reduced, a vast abundance of Ferns, and, among seed-bearing plants, a great number of Conifers, and various members of the strange race of the Maidenhair Trees, now only represented by a single surviving species, itself scarcely known in this wild state.

But, in a broad sense, the Secondary Period might be described as the Age of Cycads, a group now so dwindled as to be unfamiliar to those who are not botanists. Some reference was made to the existing family of Cycadaceæ in my 1910 address. They are now a small tropical and sub-tropical family of nine genera and about 100 species—handsome palm-like plants sometimes reaching the stature of trees. They have no affinity with Palms, but rather with Conifers, though so different from them in habit. The sexes are separated on distinct plants; the usual fructification is a simple form of cone, while in *Cycas* itself the seeds are borne on leaf-like carpels growing on the main stem. Throughout all the earlier part of the Mesozoic Age, plants of the Cycad type were extraordinarily abundant in all parts of the world, forming from one half to one third of the land vegetation, and in fact holding a place comparable to that which the Dicotyledons occupy in the living Flora. But among this great mass of Cycad-like plants only a very few are found to have had the simple fructification of true Cycadaceæ. The vast majority, while agreeing with modern Cycads in their vegetative organs, possess a totally different and much more advanced reproductive apparatus.

The true nature of the dominant type of Secondary Cycadophytes was first revealed by the Isle of Wight fossils, and especially *Bennettites Gibsonianus* found at Luccombe Chine, near Shanklin, in the Lower Greensand. about the year 1856. Our knowledge of the structure of this remarkable fossil, which has proved so important to students of evolution, is due, in the first instance, to the classic investigations of Carruthers, and subsequently to the work of a distinguished German botanist, Count Solms-Laubach. The structure of the stem, enclosed in an armour of persistent leaf-bases, is in essentials that of a recent Cycad, and from indirect evidence, derived from other specimens, there is no doubt that the habit of the plant was also Cycadean. But, when we come to the reproductive organs, everything is different. The pear-shaped fruits are borne laterally on the stem, closely wedged in among the bases of the leaves. They have a complex structure. The short, thick stalk expands at the top into a dome-

shaped cushion, on which are inserted a large number of slender rods or pedicels, each terminating at its apex in a single erect seed. Among the seed pedicels a still larger number of sterile organs are borne, the whole forming a closely packed mass. The sterile organs spread out at the top and coalesce, forming a wall to the fruit, interrupted only by minute apertures into each of which the tip of a seed is tightly fitted. The whole is enclosed by a number of overlapping bracts which spring from the fruit stalk, so that the fruit has the appearance of a large bud.

The cavity of the seed is filled by a large, dicotyledonous embryo. It is only in the genus *Bennettites* that the embryo has been found preserved in a fossil state. Its presence shows that the fruit was mature at the time of fossilisation.

The structure of the flower, as distinguished from the fruit, was first made known by Wieland's researches on the abundant American specimens. He showed that the arrangement of the parts was essentially the same as in a modern bi-sexual flower; on the exterior the overlapping bracts represented the perianth; next came a ring of large, branched stamens, bearing very numerous compound pollen-sacs, while the middle of the flower was occupied by the ovule-bearing organ, representing the pistil. In detail, however, the parts of the flower were very different from those of any living flowering plant, the stamens, for example, rather resembling the fertile fronds of a fern.

The nearest analogue among recent flowers is to be found in *Magnolia* and its allies, but the resemblance is a distant one.

That family of Cycadophytes, of which *Bennettites* is the type, were enormously abundant in Secondary times, but they did not stand alone.

There is also the extensive group of the *Williamsonias*, discovered much earlier; *Zamia* (now *Williamsonia*) *gigas*, from the Lower Oolite of the Yorkshire Cliffs, having been described by Lindley and Hutton in 1835. *Williamsonias* are now known from India, Mexico and Sweden, as well as England, and were no doubt of world-wide distribution. They were closely allied to the *Bennettites* family, but, unlike the latter, appear to have had tall stems. The great flowers, which were probably in many cases uni-sexual, somewhat resembled in appearance the flower-heads of an artichoke.

In a Swedish Rhætic fossil, *Wielandiella*, of this family, the stem was slender and forked, quite unlike a typical Cycad.

We are led to the conclusion, on the whole of the evidence, that in the Secondary period the whole world was overspread by an immense class of plants, having much in common with the little surviving family of Cycadaceæ, but in the structure of their flowers far more highly organised, and somewhat approaching the higher Flowering Plants. In geological age they overlapped the latter, for Angiosperms occur, side by side with *Bennettites*, in the Lower Greensand and even earlier.

This is the case, for example, at Luccombe Chine, where the stems of Dicotyledons, of typical structure, occur in the same beds which yielded *Bennettites Gibsonianus*. The Secondary Cycadophyta show us what this Cycad type of organisation was capable of, in its best days, so far in advance of anything which its modern representatives have to show. They may even give us the clue to what Darwin called the "abominable mystery" of the origin of the true Flowering Plants, though they may not have been on the direct line of their descent.

NOTE.—In replying to a vote of thanks proposed by Sir Daniel Morris, and seconded by Mr. Rankin, Dr. Scott deplored the inertia of English investigators and gave instances of fruitful investigations on British Mesozoic material by foreign scientists. The recent elucidation of the structure of the Jurassic Cycads of the Yorkshire deposits, including several new species of *Williamsonia*, had been largely the work of his Swedish friend, Professor Nathorst. He was glad to say, however, that English palæobotanists were now waking up to the value of the fossil treasures of their own country.

Natural Colour Photography.

A BRIEF HISTORIC SURVEY.

By R. Y. BANKS.

Read before the Photographic and Record Section, February 10th, 1915.

IN discussing colour in photography we must first enquire into the origin or source of colour. Although colour is presented to our vision in a variety of ways the main source of all colour is light. It may seem absurd to say that without light there is no colour, but this very obvious statement might mean more than one thing. It may mean that from want of light we are unable to see the colours that are there, or it may mean that there are no colours there and that the colour is contained in the light itself. Accepting the latter theory we must assume that say red brick or green grass are not either red or green in themselves, but that they have some inherent quality of analyzing the colours of which white light is composed, absorbing some and transmitting or reflecting others. This may be simply described as selective absorption. It involves the presence of a pigment and for that reason may in connection with coloured photography be described as a pigmenting process. We shall find as we proceed with our review that this is the only way of producing coloured pictures that has up to now been brought to a successful issue and acquired a practical use. There are, however, other ways by which colour is presented to our vision and by which coloured pictures have been produced. One of these is by

interference, examples of which may be found in peacock's feathers, some stones, butterfly wings, beetles, and the ever popular soap bubble, in none of which is the colour due to the presence of a pigment. We may select the soap bubble as perhaps the best illustration. Although the film may appear to be of one substance throughout it is in fact irregular in thickness, and it is through this irregularity and the extreme thinness of the film that we see the colours and even pictures of surrounding bright objects. The principle has been applied to the production of natural colour photography, and it is the only principle to which this term can apply. A diffraction process of colour photography was expounded by Professor Wood in 1899, but nothing practical came of it, so those workers who had directed their attention towards the pigmenting method were left masters of the field.

In taking a historic survey of the colour question, it is interesting to note that, like so many other things, it came to us mainly by suggestion. These suggestions have been persistent throughout the whole time that we have had any knowledge on the subject. Many discoveries in photography have been brought about by accident. The Daguerreotype plate was due to the placing of an exposed plate by inadvertence near the vapour given off by mercury. The discovery of the action of light on a silver salt was due to the use of nitric acid which had previously been used to dissolve silver. The orthochromatising of plates was due to an accident without which little progress would have been made with colour photography. Pyrogallie acid for developing was also an accidental discovery. But photography, colour photography, and cinematography, through the desire to possess all these things, have come to us by suggestion. Let me illustrate: In the year 1558 an Italian professor was showing to his friends a scientific instrument which he called a camera obscura, literally a dark box. In principle this was exactly the same as the camera we now carry about in our pockets. In this instrument there was, first of all, a picture of any object to which the lens was presented—a picture written with pencils of light—which to-day we call photographic: the picture was in colour—the pure colours of nature—bringing us to colour photography: lastly, if there was any movement this would be shown on the receiving surface, so giving us the suggestion of cinematography. None of these things seem to have suggested themselves to the professor's mind and centuries pass before we hear of them again. To find any practical result from these suggestions we must come down to about the year 1824. At this time we find Daguerre unsuccessfully attempting to fix the image seen in the camera obscura, which he used for sketching purposes, being himself a scene painter and panoramist. Later Niepce joined him in his researches, with the result that we all know. So far we have got only as far as the discovery of photography, though there is very little doubt that Niepce came very near to the discovery of colour by the interference method.

From this time onward a host of workers have been experimenting in the production of a photograph in colour. We shall now consider how far they may be said to have succeeded.

In order to attack the problem in a scientific way it was necessary that certain bases should be established. From these experiments were made in all directions, some in the way of the interference principle, some towards diffraction and others towards the pigment method. One great bar was the question of what were the primary colours. Scientists were very much at variance on this point, and the number of colours thought necessary to reproduce all the colours of nature ranged from three to some eight or nine. One or two put out the theory that red, yellow, and blue were the primaries, but they at last fell into line with the majority who had accepted the theory that red, green, and blue were the three colours required to produce coloured photographs either on glass or paper. It is usual, however, to describe the red as orange red and the blue as blue violet. In practice, however, a fourth colour is used, viz., yellow, but this is for a specific purpose which will be explained later. This brings me to a few remarks on the varying wave lengths of colours in the spectrum, another base from which the subject of our paper springs. The activity of the waves of light at the upper end of the spectrum compared with that of those at the lower end was so great that on an ordinary plate, which is practically only sensitive to the blue violet rays, it was impossible to photograph a red object and a blue one, say the sky, on one plate with the same exposure. It is clear that while this state of things existed no advance could be made towards coloured photography. But the accidental discovery by Dr. Vogel opened up the whole question of dyed plates, the adoption of which led to surprising results. First came a plate sensitive to the green and yellow rays and known as the orthochromatic, soon followed by a plate sensitive to the red rays and described as panchromatic. What happened was a suppression of the activity of the blue violet simultaneously with the acceleration of the tardy reds. The panchromatic plate thus became the photographic basis of the screen plate photography of to-day. The use of a yellow screen is to reduce still further the activity of the blue violet and ultra blue violet, which latter are not visible to the human eye, but are capable of affecting the sensitive plate to such a degree that a photograph has been taken by these rays alone.

Having established these two important bases, the road to colour photography becomes more clear, so we now proceed to examine the ways taken in its further progress. Lippmann's process of pure colour photography by interference was so complicated that although successfully accomplished by the inventor, very few people have ever seen a specimen, and no one, as far as known, has succeeded in producing one. We will, therefore, only consider those processes that have come into practical use. There were two main lines of approach, one by the Three Colour Process

and the other by what is correctly described as Screen Plate Photography.

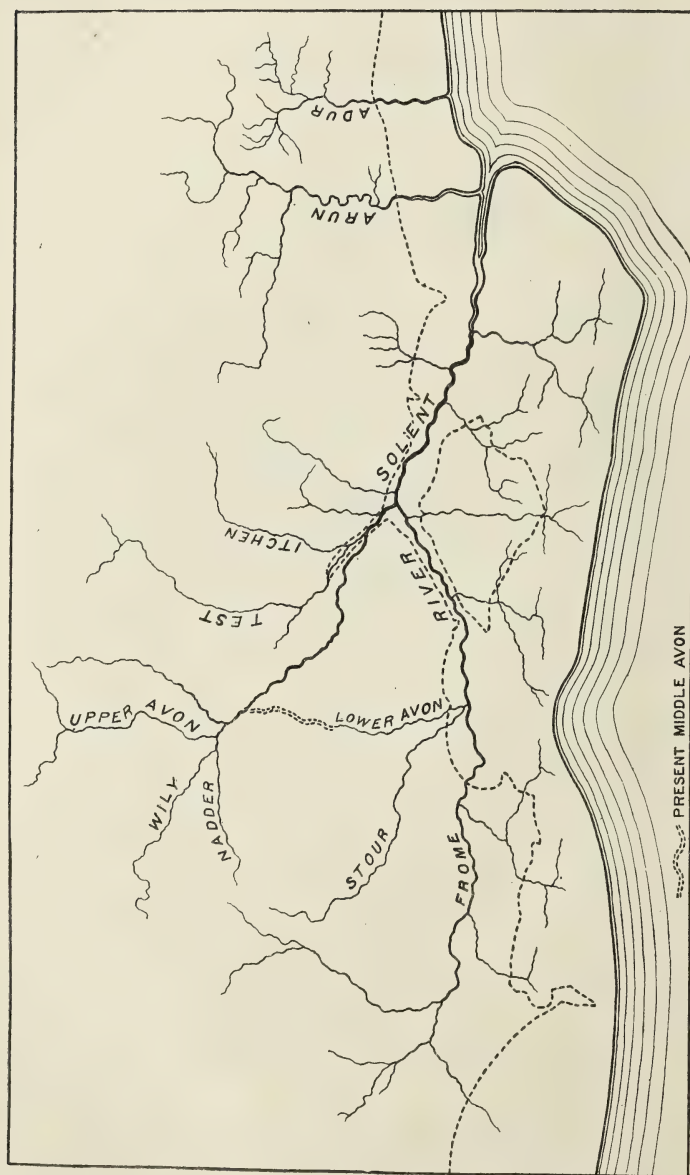
Mr. F. E. Ives, of Philadelphia, may be said to be the pioneer in practical three colour work, and when his results were made known in 1895, they created quite a sensation in the photographic world. He produced most elaborate cameras for taking the pictures, and equally elaborate instruments for viewing them. His was the first practical colour photography, and it was based upon selective absorption.

The next successful attempt was the Sangar Shepherd Three Colour Process. It was on the same lines as the Ives in its main principle, but the three negatives were superimposed so as to form one plate which could be thrown on the screen.

Our last consideration is the Screen Plate Photography previously referred to. In this the photographic basis is the panchromatic plate in which there is no colour whatever, the colour being provided by the use of a screen previously prepared with coloured pigments, and brought into contact with the photographic plate for viewing purposes. The panchromatic plate has been explained as giving the best rendering of colour values yet attained. The screen may be made in many ways, though two only are chiefly used. The one is by a mixture of fine coloured particles dusted on to a plate; the plate is then varnished, thus forming the screen; it is then coated with panchromatic emulsion on which the photo is taken. After development it is, of course, a negative, but by a chemical process it is changed into a positive and is then ready for use. This is the Lumiere process. The other method is described as geometrical, the colours being put on in lines forming tiny squares of red, green, and blue. In this the panchromatic emulsion is put on a separate plate, and a positive obtained in the usual way as in making an ordinary lantern slide. These two plates are brought together and bound up, making the complete colour picture. This is the method adopted by the Paget Co. These two plates, the Autochrome and the Paget, practically hold the field to-day; they are frequently shown together, and may be considered in a sense rivals. That in all cases they give a true rendering of colours in nature may be doubted. The density of the Autochrome renders a specially strong light necessary, which is not the case with the Paget. Greens seem to be better rendered in the Paget than in the Autochrome, while yellows seem to be given better in the latter than in the former. Autumn tints are particularly well rendered in the Paget; there would, therefore, appear to be a sphere of usefulness for both.

The space allowed for this paper is so limited that the subject cannot be dealt with as fully as could be wished, it must, therefore, only be regarded as a broad outline of a particularly interesting subject.





Sketch Map of the Basin of the Ancient River Solent.

Ancient Rivers of Bournemouth.

By CLEMENT REID, F.R.S.

(Read before the Geological Section, February 23rd, 1915.)

THE history of any place is so intimately connected with its physical geography that the physical geography cannot be ignored. In the case of a town like Bournemouth this is markedly so. Bournemouth owes its importance entirely to its position and scenery. It has no harbour, no manufactures, no mines. We will try, therefore, to show what geological changes led up to the selection of this site, and what strange vicissitudes the site went through before it became the pleasant place to live in that we now see.

I do not intend to deal fully with the ancient geological history of Bournemouth, as illustrated in our cliffs; it will suffice to begin with modern geological times. These times, however, counted in thousands of years, are long. As a beginning, we need go no further back than the Miocene, or Middle Tertiary, period, when movements of the earth's crust caused the strata to be thrown into folds, of which the Hampshire Basin is one of the most conspicuous.

The first result of this folding was the formation of a wide trough, with an uptilt at its western end. The rain-water and rivers were compelled to flow down the slopes thus formed, and so the old valley of the Solent originated.

The vital importance of the ancient Valley of the Solent in the history of Bournemouth must be realized. Later changes have greatly altered the topographical features, but the sunny southward slope of gravel on which Bournemouth is now built owes its origin to the former existence of a big river. We will, therefore, attempt to trace step by step the history of the Solent River, from the earliest stages to the present time. Nowadays the valley is so altered and cut into that only the geologist sees what an important feature in the landscape it must once have been; he alone sees how many traces of it still remain.

The Solent at one time was one of the largest rivers in England. It rose far away in the west, flowed a mile or two south of Bournemouth, and passed through the present Solent to Spithead—where we can see how wide is the valley from hill to hill. Eastward it was prolonged many miles, probably in early times as far as the end of the South Downs at Eastbourne. It had then many tributaries on the south, as well as those still existing on the north.

Gradually the encroachments of the sea cut off the heads of many of the southern tributaries, opened up the estuary on its south side, and shortened the river, till it was something like what is shown on the map facing this page.

As far as I can at present make out, the Solent Valley was much in the state depicted towards the close of the Pliocene Period;

that is to say at a period when there is at present no satisfactory evidence that man had yet reached Britain.

You will naturally ask how this restoration of the boundaries of land and sea is arrived at; when the evidence has been so completely swept away, as is shown east of the Isle of Wight, where the whole of the southern side of the old valley has now completely disappeared. Various lines of research led to this restoration; but some of them are so complicated that it would take too much time to deal with them now. We will, however, take the evidence of the first glaciation in Britain, and will see what modifications in the topographical features it points to in the regions with which we are now dealing.

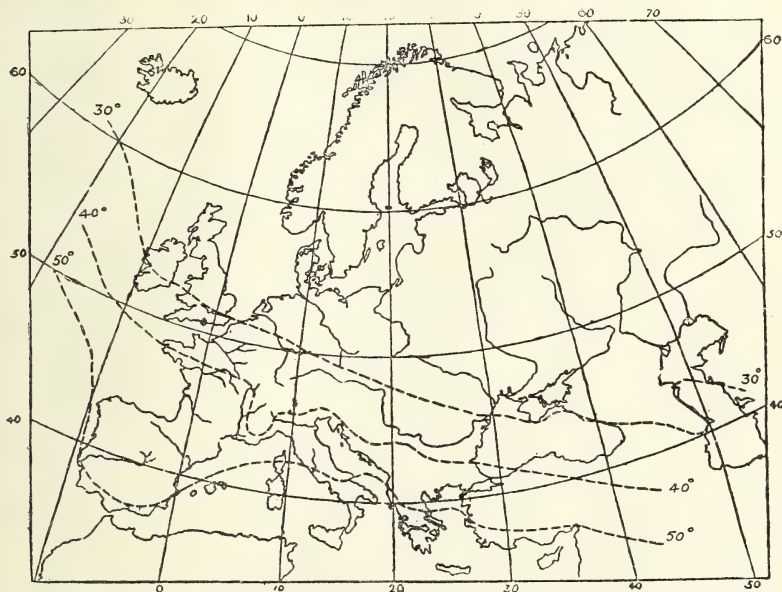
During the Glacial Period the cold was so intense that the greater part of Britain was smothered under ice and snow. Even in these southern latitudes around Bournemouth the cold was so great that the seas were blocked in winter by floe-ice, and the soil was deeply frozen. There were no towering icebergs here during the greatest intensity of the cold; for though the climate was so cold, no glaciers reached the sea on the borders of the English Channel.

To realize clearly what it was like in the South of England, a few words more are necessary as to what happened there. In order to understand our valleys we must first grasp the climatic changes which so greatly influenced their formation. This is all the more necessary because some of the most striking evidence has not yet found its way into the geological text-books. Indeed, naturalists in this country have as yet little conception how greatly conditions were modified for a time, or how sweeping were the changes in the fauna and flora. Geographers also scarcely understand the greatly increased rate of erosion which was then in progress, or the peculiar modifications of the processes of erosion caused by the cold.

Try and imagine what it must have been like when the climate was about 20 degrees colder than now. Many years ago I made an isothermal map of NW. Europe, but if anything the degree of cold was somewhat underestimated, however, I here reproduce it on page 75. On this map the line showing a mean annual temperature below the freezing point is found far to the south, and passes through London. With such a climate, an Arctic vegetation must have clothed the whole of the south of England. As a matter of fact, many Arctic plants have been found fossil in the Lea Valley, close to London, and the dwarf Arctic birch has been found as far west as Bovey Tracey, in Devon, in one of the hottest valleys in Britain. Unfortunately we have not yet discovered this Arctic flora near Bournemouth, and it is one of the things still to be searched for.

As regards the fauna we are more fortunate, for only a few miles away, in the suburbs of Salisbury, a thoroughly Arctic fauna has been found, including reindeer, musk-ox, Arctic-fox, lemming, and many others.

ISOTHERMAL MAP, SHOWING THE PROBABLE MEAN ANNUAL TEMPERATURE (FAHRENHEIT) DURING THE GREATEST SEVERITY OF THE GLACIAL EPOCH.



NOTE.—No attempt has been made to restore the ancient topography; as far as yet known there was little change in the boundaries of sea and land during the glacial epoch.

The soil and subsoil during such a time must have been deeply frozen all the winter. When the spring thaw set in, the rush of water over the still-frozen and impervious sand or chalk caused the surface everywhere to be torn up and channelled in a way that we now never see in the south of England. For such rapid erosion we have to go to the frozen lands of Siberia and Canada. It is under conditions such as these that the dry valleys in the plateaus about Bournemouth were formed, as well as the dry coombes in the chalk of Salisbury Plain and the South Downs.

During this period of intense cold the English Channel was to a large extent frozen over, and drift ice breaking away in the spring carried erratic blocks far and wide, transporting them across the Channel with the greatest ease.

It may seem that I am getting somewhat far away from my subject; but it is not so. In order to understand the formation of the valleys of Bournemouth, the climatic vicissitudes that we have passed through must be realized. We will, therefore, examine a little more of the abundant evidence for such vicissitudes in the south of England.

The first point to make clear is that the climatic changes we speak of were very sweeping, covering a wide area in Europe, and perhaps affecting the whole northern hemisphere. They were not slight changes caused by varying elevations of the land, or anything of that sort.

It is obvious that the temperature of the sea can have little to do with variations in the height of the land. Our warmth in the south and west of England now comes from the Atlantic—how was the Atlantic then affected ?

A few years ago we could not have answered this question with any degree of confidence; but whilst I was in charge of the Geological Survey of the south of England I was asked by one of my colleagues to come over to the Isles of Scilly and see some curious boulder-beds. The Isles of Scilly are composed of granite, and of nothing but granite; the boulders there found, however, included a variety of rocks—sedimentary, igneous, and metamorphic. The most abundant were of a pale-reddish sandstone, unlike anything in Cornwall or Devon. These were subsequently identified as coming from the Upper Old Red Sandstone of the south of Ireland. A large proportion of these blocks had been scratched, striated, or polished by moving ice—nothing else gives these curious faceted surfaces covered with parallel scratches. The erratic blocks usually occurred only a few feet above the sea-level, though in certain places they could be traced up gentle slopes nearly to the highest points on the Isles. These places were in bays open to the west wind—just the sort of places where the ice floes would accumulate, and, driven by the spring gales, would be forced up the slope and piled high above the sea-level. In places where abrupt cliffs face the sea the boulders were only found near their foot.

This compels us to picture a time when the Isles of Scilly, now surrounded by a sea so warm that frost scarcely ever touches the vegetation, lay in an ocean so cold that ice-floes could travel all the way from the south of Ireland, bearing with them numerous ice-scratched blocks of sandstone. Possibly with this floe-ice were a certain number of bergs broken off from the Irish glaciers, which certainly descended to the sea-level and sent tongues out into the Atlantic. Most of the erratics, however, look like beach-stones frozen into the ice-foot, and drifted away when the ice broke up in spring.

It may be said that this Arctic sea, though it affected the Isles of Scilly, did not reach as far east as Bournemouth and the Isle of Wight. However, the evidence is equally strong in the Selsey Peninsula, where a very similar erratic-bed is found. The Selsey erratics are most instructive. Few of them are striated, and the striation is probably only such as would be caused by ice driven by the tide across submerged reefs. A striated block I found is composed of hard fossiliferous sandstone, and comes probably from Bognor Ledge, a reef of rocks running a good way out to sea at Bognor.

Though not many of the Selsey erratics show glacial striæ, and the only agency of transport seems to have been ice-foot or shore-ice, there is an astonishing mixture of far-transported masses. In addition to the masses of Bognor rock just mentioned, there are numerous greywethers or sarsen stones, pieces of pudding stone, and masses of unmistakable Bembridge Limestone from the Isle of Wight. These represent the Tertiary strata. The Secondary formations are represented by numerous large unworn flints, and by masses of Greensand chert, both probably derived from the southern part of the Isle of Wight. But among the more striking large erratics are masses of igneous and metamorphic rock from the Channel Islands or coast of Brittany. One small block of granite was evidently Cornish.

So the English Channel was then as cold as the Atlantic round the Isles of Scilly—cold enough for a thick shelf of ice to accumulate along the shore every winter, and then to break away and transport masses weighing a ton or more right across the Channel. The ice must have been thick, in order to support such blocks, and the water must have been so near the freezing point as to allow the floes to drift hundreds of miles before they melted away.

A curious problem arises when we study the distribution of the erratic blocks in the south of England, and its solution ought to throw much light on the distribution of land and water during the period of greatest cold. It will show that the apparent digression we have been making is very much to the point, when we study the ancient valleys of Bournemouth.

Selsey shows an accumulation of erratics drifted from many different places, and the same is the case with the scattered erratics which are found all along the Sussex coast, and even here and there on the coast of France. But as we pass westward into the old estuary of the Solent these erratics disappear, till we have only large blocks of greywether sandstone, such as can be seen in abundance on the foreshore at Milford-on-Sea.

This fact seems to imply that at the period when the erratics were being carried, the mouth of the Solent River was not far from Spithead. Outside Spithead drift-ice from the shores of the English Channel brought erratics, and some of this ice probably travelled with the tide a short distance up the estuary. Inside Spithead, on the other hand, and everywhere higher up the old river, only erratics brought down the stream by river-ice are found, for all the Milford erratics may have come from the upper waters of the present Frome or Avon.

The occurrence of numerous large sarsen-stones at Milford and Barton, unmixed with stones from the Isle of Wight or Channel Islands, seems, therefore, to prove this point—it shows that the chalk hills of the Isle of Wight were then still continuous or almost continuous with those of Dorset, and that Bournemouth was then on the bank of a river, not on the shore of the sea. This gives us an approximate date for the breach in the hills on

the south side of the valley, opposite Bournemouth, and for the formation of Bournemouth Bay; it took place after the first glaciation, or we should find the foreign erratics near Bournemouth and Poole, just as they are found at Selsey.

I want particularly to draw attention to this recent date for the inroad of the sea into the Solent valley opposite Bournemouth. It is a new point. Formerly I thought that this gap dated back to the Pliocene period; but closer studies convince me that the breach was only made after, not before, the time of maximum glaciation. Man may well have seen this great change in physical geography, and may have watched the sea break through the wall of chalk during some storm.

This will give some idea as to how a geologist reconstructs ancient lands, and how he correlates changes of land and sea with particular periods of heat or cold, the date of which is already known approximately. We may take it that during the first glaciation Bournemouth lay on the shore of an Arctic river, and was far distant from the sea. Look at Lyell's picture* of the shores of the River St. Lawrence, strewn with far-transported erratics, brought by the floating ice in spring. This gives a fair idea of what the Solent River was like during the first glaciation.

Before leaving this question I would like to draw attention to some effects of the cold, effects which make for extremely rapid changes in the physical geography while the cold lasts. These changes are far more rapid than any we are accustomed to under present conditions. I do not wish it to be thought that there is any necessity for periods of millions of years in order to allow time for the changes such as we have suggested that man saw near Bournemouth.

We now see the Hampshire and Dorset rivers flow gently down their slightly inclined beds, even in flood times not greatly eroding their channels or widening their valleys. We see also that the waves of the sea only cause encroachments averaging a few inches each year. We naturally think at this rate many years would show no great change. But even at the present slow rate of erosion the breach into the Solent Valley opposite Bournemouth cannot have been made at any very remote period. It is difficult to get a satisfactory estimate of the average rate at which the cliffs are receding, but taking it at six inches annually we find that the chalk hills of Dorset and the Isle of Wight would be continuous across Bournemouth Bay about 50,000 years ago—and this, geologically, is quite recent. However, we cannot get at dates in this rough and ready way, and there are various other things to be taken into account before we can give a date to this great change.

Amongst the things which must influence the rate of valley-erosion, and the rate of the cutting back of the sea-cliffs, the first place must be given to climatic changes. With an Arctic

* Principles of Geology, 12th edit., Vol. I., plate 4.

climate conditions would be entirely altered, even if the combined rainfall and snowfall were no greater than now. During the long winter, erosion would almost cease, but during the spring the rainfall and the melting of the snow accumulated during several months would cause floods such as we now never see in the south of England. Not only so, but the formation of bottom or anchor-ice, and the floating off of large cakes of ice laden with stones would clear away and sweep down the streams large boulders such as no flood nowadays can move. This again would help to keep the channels clear and allow a greater sweep for the floods.

Under Arctic conditions the sea-coast would show a wide belt of ice-foot or shore-ice under the cliffs, and this would in winter deaden the action of the waves. Thus there would be little change in winter, except for the universal shattering and loosening of every cliff-face not protected by snow. In spring, however, this would be entirely altered. First, the shattered cliff-faces towards the sun would thaw and fall on to the ice-foot. Then, as spring advanced, the gales and tides would loosen this ice-foot, and it would float away in large cakes, not only with its burden of fallen blocks, but with a quantity of imbedded beach stones frozen into its substance. These boulders and pebbles which, under existing climatic conditions, tend to accumulate on the beach and protect the foot of the cliff, would, under Arctic conditions, be swept out to sea and dropped into deep water. Thus the cliff itself, unprotected by beach, was left exposed to the grinding and undercutting caused by the drifting to and fro of the ice with every tide.

Imagine what this would mean at places like Hengistbury Head or at Swanage. In both these places the cliff is now protected by a talus of large fallen blocks. Consider what would happen if a winter's ice enclosed all this coarse material, lifted it, and swept it out to sea, thus leaving the cliff-foot undefended from the ice. Probably the annual loss of land would be at least ten times what it is now.

I particularly want you to realize this effect of the cold, for people often say that sea and rivers work very slowly, and that therefore great changes such as are depicted on the map must have taken an enormous time. They say also that if man saw great changes of this sort his first appearance in this country must be so ancient as to point to the lapse of millions instead of thousands of years. This idea is erroneous, for as soon as Arctic conditions supervene, the rapidity of the changes is enormously increased—and we know that Britain under Arctic conditions was already inhabited by man.

I do not want to suggest that the whole of the strata which contain evidence of man's handiwork can be brought into a few thousand years. I only want to point out that the rapidity of the changes in physical geography, in the fauna, and in the flora—and these changes are the scales by which we usually measure geological time—are governed to a large extent by climatic conditions. However, as regards the period of first or maximum

glaciation about which we have been speaking, we have as yet no clear evidence that man then lived near Bournemouth.

After this period of intense cold came a time when the climate was mild, and southern animals and plants returned to England. We have found on our south coast in some of the deposits such southern plants as the Montpellier maple and *Cotoneaster pyracantha*. This interglacial period saw a considerable variation in the sea-level, the sea at one time rising about 140 feet above its present level, as is evidenced by the raised beach in Goodwood Park and by the deeper-water shell beds of Selsey. Then the sea gradually sank to its former level, and there were laid down deposits of estuarine and fluvial origin along the course of the Solent River and in the Selsey peninsula. It is in these later deposits that the southern plants have been found, but southern marine mollusca are abundant in the underlying marine deposits.

Unfortunately no fossils belonging to this interglacial period have yet been found near Bournemouth, though some of the flint implements probably belong to it.

After the formation of the estuarine deposits there seems to have been a submergence of a few feet, and the overlying beds of beach-shingle were formed, as well as the low-lying raised-beach at Brighton. Thus far I have been unable myself to find any trace of man in these fossiliferous interglacial beds; here, however, probably belongs the strange extinct type of human skull, discovered by Mr. Dawson, at Piltown, and named by Dr. Smith Woodward *Eoanthropus dawsoni*. I do not know where else the deposits in which it is found can be placed.

Perhaps we shall make similar discoveries near Bournemouth in one of the terrace-gravels that help to make up the enormous sheet which covers the plateaus. We have, however, here two difficulties to contend with. Our gravels are mainly decalcified; that is to say, percolating rain-water has dissolved all lime and has consequently destroyed any fossil bones that may have been in the gravel. And, secondly, such enormous quantities of flint gravel have been swept down from the chalk hills lying to the north and west, that it becomes difficult to find implements in deposits formed when men were few.

At present we do not quite know what happened in the Solent River during the period of greatest submergence. The sea may have extended far beyond Bournemouth into Dorset; or more probably the valley floor was not then cut sufficiently low to enable the sea to run far inland. This is one of the difficult questions that we still have to solve; at present we cannot point to any decisive evidence either way.

You may say that it ought to be quite easy to trace the raised beaches of Goodwood and Portsdown, Bembridge and Portland into the Solent Estuary. But after several years' work at the field geology I could not satisfactorily do so. The difficulty is this: At that period, as now, the prevalent wind seems to have been SW., and shingle beaches were formed in all exposed places. But

when these shingle beaches are traced round the corner, into the shelter of the Isle of Wight, they rapidly change their character, become less pebbly, and finally are indistinguishable from ordinary river gravels. Thus I cannot tell you for certain whether any part of the big sheet of gravel near Bournemouth is of marine origin or whether it is all fluvial. My impression is that it consists of terrace-deposits formed at different levels, corresponding with the varying levels of the sea outside, but itself is not actually of marine origin in any part.

After the mild period the cold came on again, and we had a second glacial period. During this, the sea-level seems to have been a few feet lower than now; but how much is not yet known. The contours of the Solent Valley, in the part between the Needles and Spithead, were probably in a general way much as we now see them. But the gap opposite Bournemouth may not have yet been cut, though the barrier of chalk on the south of the river was getting very weak, and in places very low. It was probably cut through during this second cold period.

An observer standing at Bournemouth during this second cold period would probably see a wind-swept open plain sloping southward to the Solent. Beyond the Solent on the left he would see the Isle of Wight; to the right would rise the Isle of Purbeck. Between, these were connected by a narrow ridge of chalk, or series of chalk hills, and through the gaps the sea was already visible. There were probably no trees, only dwarf Arctic shrubs and patches of peat-moss. The reindeer and lemming were the most abundant animals, though the Arctic fox and wolf were common, and the long-haired mammoth was also found.

It was probably also during this second cold period that the gaps opposite Bournemouth became so wide that the sea was able seriously to attack the soft Tertiary strata. This advance of the sea, perhaps combined with a blocking of the mouth of the river by ice during a flood, allowed the Solent to overflow and find a new and more direct course through one of the already formed gaps. Thus our big river-valley became divided into several small separate catchment basins, the western alone opening into the newly-formed Bournemouth Bay. Bournemouth was then for the first time a sea-side place, or rather was within three or four miles of the sea, and had an open view seaward.

Concurrently, perhaps, with this shortening and lowering of the bed of the River Solent there was another change. Of course as this is a country of loose sands and clays, rather than of hard rocks, its tributaries had their beds lowered in a corresponding degree. One result of this was that the Upper Avon, which before flowed into Southampton Water, was also diverted into a more direct course to the sea. Exactly how and when this happened is not yet clear, but I think that the diversion was probably due to the lowering of the bed of the Lower Avon near its head to such an extent that the water of the Upper Avon soaked through the sandy strata and emerged at the head of the

Lower Avon as springs. Such springs, once they were started, would steadily cut back till the dividing wall gave way and the older river was diverted into its new course.

After this cold came a transition to a milder period, but about the actual stages of the transition we still know very little. We do know, however, that the sea-level was at one time somewhere about 80 feet lower than now, and then gradually rose again step by step, with stationary intervals when there was time for forests to grow, before they were overwhelmed and buried under marine silts. During this period the valley bottoms were cut far below the present sea-level, and the rivers after leaving the hill-country wandered over a wide belt of flat land before reaching the sea. I have not yet been able to reconstruct the topography of the English Channel for the period when the lowest of the submerged forests were growing; but from evidence obtained by trawlers I have been able to restore the vast alluvial plain which then occupied the southern half of the North Sea. In the map in my little book on Submerged Forests you will see depicted a vast delta formed by the Rhine, Meuse, Elbe and other rivers. I examined many dredged samples of the deposits found in the North Sea on and around the Dogger Bank, and they were full of the remains of freshwater and marsh plants.

Gradually the land again sank, till the sea reached its present level, probably 3,000 or 4,000 years ago. Then Bournemouth must have had a prospect very much like that we now see, except that the cliff was probably much lower, and a mile or two further seaward. Also, Bournemouth Bay was somewhat less wide, for the Needles stretched somewhat further to the west, and the corresponding chalk headland of Dorset stretched further east towards them. The Isle of Wight still remained for a good many centuries attached to the mainland opposite Yarmouth, but this attachment was only by a narrow neck, which only disappeared finally in historic times.

Thus step by step we have watched the initiation of a big river system, followed by the breaking up of the catchment area into a number of separate basins and valleys. Incidentally, in the diversion of the Upper Avon, we have seen one of the most interesting, if not the largest, instance of river-capture yet found in England; the Avon, from a small and probably peaty stream becoming thus the clear and perennial salmon-river we now see. Thus have originated the Valleys of Bournemouth, and their study has been one of the most interesting I have come across. There is, however, still much to be learnt, and you must not go away with the idea that there is nothing left for local workers to do. Each time we solve one geological problem others arise, which cry for an answer. We still know very little of what happened in these regions during the Glacial Period, or of man's first appearance on the scene.

Woodlice.

By W. OMER COOPER.

(Read before the Zoological Section, March 6th, 1915.)

THE Oniscoidea or, as they are commonly called, Woodlice, belong to the class Crustacea. Together with numerous marine species and a few which live in fresh water they form the Order Isopoda, but, owing to their terrestrial mode of life, they have become widely different in appearance and structure from other Crustaceans and were classified by many of the older naturalists among the insects. As Mr. Stebbing tells us, "the one feature of the moral character which all Isopoda possess in common" is a prudent love of obscurity and consequently they are little known to any but specialists, although their abundance and the considerable economic importance of some of the marine forms, such as the notorious Fish-Lice, should lead to their more general study.

At the present time Woodlice have no commercial value, but it is interesting to note, with regard to those species, such as the familiar *Armadillidium*, which roll themselves into balls, that the London College of Physicians formerly prescribed them in various cases of illness, and, swallowed alive like pills, they were once a well-known, though, I should imagine, hardly a popular remedy. They were also, I believe, administered to cows to "promote the restoration of the cud." To the horticulturist they are, of course, only too well-known, but there seems to be a considerable amount of doubt as to the injuries done by these creatures: it is, however, apparent that they do eat the roots of various plants and such things as mushrooms, etc., to an extent which must seriously affect the condition of the garden. But in spite of their economic and "medical" interest, the Woodlice have been little studied until the last few years when they seem to have become a more popular subject. This is, I think, due in part to the appearance in 1906 of a small work on the British species by Mr. W. M. Webb, the well-known secretary of the Selbourne Society, which attracted a good deal of attention on account of its excellent and popular style. The book contains several striking inaccuracies and is almost worthless for the identification of specimens, but it is splendidly illustrated and certainly served to arouse interest in the group. The chief scientific works dealing with the Woodlice are the late Professor Budde-Lund's "*Crustacea Isopoda Terrestria*"—a fine work, but, unfortunately, written in Latin—Volume 2 of Sars' "*Crustacea of Norway*," and various scattered papers by M. Dollfus, the Rev. T. R. R. Stebbing, Canon Norman, Dr. Scharf, Mr. Bagnall, and others.

These authorities differ considerably in their schemes of classification for this group, but to me the most satisfactory appears to be that of Professor Budde-Lund, who divides the whole of the Oniscoidea, with the exception of a few aberrant

genera, into two families, *Ligiæ* and *Onisci*, distinguished by various anatomical details, the most distinct of which are the form of the uropods and the number of hairs on the inner plate of the maxillulæ—three in the *Ligiæ* and two in the *Onisci*. The anatomy of the terrestrial Isopods has been fully described in various zoölogical works and is, of course, very interesting for comparison with that of the marine species as showing the modifications of structure caused by a life on land. For one thing, all the mouth-parts are reduced, and, so to speak, solidified: all the long hairs so characteristic of the mouth-parts of the aquatic Isopods, where they serve to direct and filter a current of water, are absent. The mandibles are large and strong, while the maxillipeds are fused in a somewhat remarkable manner. Then the breathing apparatus is, of course, quite changed as that of the marine and freshwater species is entirely adapted for an aquatic existence, and in certain of the woodlice the need for some other method of obtaining oxygen is supplied by a system of "pseudo-tracheæ" in the pleopods. These bear a considerable likeness both in appearance and function to the tracheæ of the insects, and consist of ramifying tubules filled with air and opening to the exterior by slit-like apertures. It is interesting to note that these pseudo-tracheæ do not occur in the *Ligiidæ* or more primitive types, and increase in importance as they appear in the more specialised genera. One of the most primitive woodlice is the "Quay-louse," *Ligia*, while the form most adapted for a terrestrial life is possibly the familiar *Armadillidium*, which is an example of extreme specialisation. Its habit of rolling itself into a ball when alarmed (in which it seems to have advanced along the same lines as the "Pill-Millepede"); its reduced antennæ and unobtrusive uropods and short legs; its power of existing in a dry atmosphere and its advanced pseudo-tracheæ all make it fit in the highest degree for a life upon land.

As with so many groups of Crustacea, it is difficult either to arrange the woodlice in any definite and scientific order of relationship or to find the connection between them and the other Isopoda. Certain aberrant foreign genera, *Helleria* and *Tylos*, have even been looked upon as terrestrial members of the sub-order Valvifera, and various attempts have been made to show the relationship of the Oniscoidea to this and other groups, but the matter needs much fuller investigation than it has so far received.

There are in all, I believe, some 34 of the Oniscoidea recorded from the British Isles, of which number I have taken 18, or just over half, from our district, and I have no doubt that a thorough search would result in the discovery of three or four more species in this neighbourhood. The other British species are mostly very local in distribution, and are not likely to be taken here. Only six or seven species appear to have been previously recorded from Hampshire, and I have, therefore, thought it advisable to prepare a list of species which I have taken here,

more especially as there is no mention of the woodlice in the "Natural History of Bournemouth."

The best known of the Ligiaæ is *Ligia oceanica*, the familiar "Quay-louse" which occurs plentifully on the various quays within our district and all along the coast at Swanage, Poole, Mudeford, etc., where these fine Isopods may be seen in numbers slipping from stone to stone or among decaying weed just above high-water mark. This is the largest and in many way the most primitive of our British Woodlice, and may almost be classed as a marine species. It seems strange to find representatives of such a typically terrestrial group living on the shore within reach of the waves, but another British Woodlouse, *Philoscia Couchii*, is found in similar situations. I have taken this species at Freshwater Bay in the Isle of Wight, where it occurs in considerable numbers, but I have failed to find it anywhere else in the district. Its occurrence so far East is of great interest, as this species belongs to the well-known West-coast group of animals and plants found chiefly in Ireland, Cornwall and Spain. This species was identified for me by Dr. Calman, of the British Museum, who tells me that there is no other record of its occurrence anywhere along this coast.

The majority of the other Woodlice found here are of little interest to the general public. *Oniscus asellus* and *Porcellio scaber* are, apparently, generally confused under the beautifully indefinite name of "The Common Woodlouse," and several other species are very plentiful in our gardens. The little blind white Woodlouse, *Platyarthrus Hoffmannseggii*, is of some interest, as it is only found in ants' nests, where it would seem to act as a scavenger: it is very abundant in some parts of this district.

Many species occur in greenhouses, and gardens are also great hunting-grounds. On the whole I do not think that this district is a specially good one for the Oniscoidea, but there is everywhere a great deal of work to be done on this group. It is probable that within the next few years a good deal of attention will be paid to the Woodlice from an economic standpoint, but at present far too little is being done in the matter.

To the Anatomist, to the Classifier, and to the Economist, the Woodlice form one of the most interesting groups. It is earnestly to be hoped that public interest will shortly be roused and that the study which they merit will be accorded to them.

A LIST OF ONISCOIDEA (WOODLICE) RECORDED FROM THE BOURNEMOUTH AREA.

W. OMER COOPER.

Ligiidae.

<i>Ligia oceanica</i>	...	...	Common along the shore, Christchurch, Poole, etc.
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Trichoniscidae.

<i>Trichoniscus roseus</i>	...	...	Greenhouses, Bournemouth. Under stones, Swanage.
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Trichoniscus pusillus	...	Common almost everywhere.
„ pygmaeus	...	Swanage.
„ Stebbingi	...	Greenhouse, Bournemouth.
Haplophthalmus Mengii	...	Holdenhurst, Swanage, etc. Greenhouses, Bournemouth.
<i>Oniscidae.</i>		
Platyarthrus Hoffmannseggii		Frequent in ants' nests throughout the district.
Oniscus asellus	...	Common almost everywhere.
Philoscia muscorum	...	Common under bark and among moss.
„ Couchii	...	Freshwater Bay (identified by Dr. W. T. Calman).
Porcellio scaber	...	Common almost everywhere.
„ dilatatus	...	Greenhouses, Bournemouth.
„ pictus	...	Swanage.
Metoponorthus pruinus	...	Common in hot, damp situations.
„ cingendus	...	Freshwater (identified by Rev. T. R. R. Stebbing, F.R.S.).
<i>Armadillidiidae.</i>		
Armadillidium vulgare	...	Common almost everywhere.
„ nasatum	...	Greenhouses, Bournemouth.
„ pulchellum	...	Yarmouth, I. W.

NOTE.—The two species, *Philoscia Couchii* and *Metoponorthus cingendus*, belong to the West Coast Group and have not been previously recorded east of Devonshire.

L I M E.

A series of papers dealing with the Compounds of Calcium in their
Chemical, Geological, Geographical, Botanical, and Utilitarian
aspects.

I.

Lime and other compounds of Calcium, considered from the standpoint of Chemistry and Physics..

By HUBERT PAINTER, B.Sc., F.C.S.

(Read before the Physical Section, January 9th, 1915.)

I HOLD in my hand a natural crystal of Iceland Spar. This is the purest form of a chemical compound which occurs in enormous quantities in the earth's crust. Marble, chalk and the various limestones are, as regards chemical composition, one and the same substance with the specimen I hold up before you. They differ, of course, from this and from each other, in various respects, in hardness, in mechanical structure, and, more important still, in history. The manner in which the great deposits of limestone, chalk, etc., have been formed it is no part of my present purpose to expound; these and cognate matters will be more appropriately dealt with in subsequent lectures to be given in other sections. We are at present concerned with the unity of

their chemical composition, not with the diversity of their modes of origin. To mark this unity we require a name that shall embrace them all, and we will use the name given in systematic chemistry, that is to say, *Calcium Carbonate*, or *Carbonate of Calcium*. Incidentally I may observe that such a name; while giving to those who have even a smattering of chemical knowledge, valuable information as to the chemical relationships of the substance; has a disadvantage as compared with a unitary name such as *water*. A double-barelled name like calcium carbonate is apt to mislead those who have not studied chemistry, since it fails to suggest that it is the name of a single substance and not of a mixture. Let me remind you, then, that by calcium carbonate I mean a perfectly definite compound, capable of being built up from and of being resolved into other substances simpler than itself, but, nevertheless, a *single* substance and not a mixture.

Calcium carbonate is only very slightly soluble in pure water, 14 parts in one million, or about one grain in one gallon, or 1lb. in 7,000 gallons. If the water contain, as many natural waters do, carbon dioxide, or carbonic acid gas, its power of dissolving calcium carbonate is considerably increased. The solubility increases with the amount of carbonic acid up to a maximum about 82 times as great as that in perfectly pure water. The increased solubility probably depends on the formation of a new compound, *Calcium Bicarbonate*, related to the carbonate just as the sodium bicarbonate used in medicine and cooking is related to common washing soda. When calcium carbonate is heated it begins to break up into two substances entirely different from itself, each of which is simpler in composition than the parent substance, but neither of which is an element. These substances are *Lime* and *Carbon Dioxide*. The decomposition, or, as it is often called, dissociation, has been very carefully studied. It is scarcely perceptible below 1,000° F. and at this temperature it proceeds but a little way unless the disengaged carbon dioxide is swept away as fast as it is liberated by a current of some indifferent gas. At about 1,700° F. the decomposition is complete if the heating be performed in an open vessel, but not otherwise.

On the large scale lime-burning, as the process of decomposing calcium carbonate by heat is called, is carried out in special furnaces called kilns. There are two main types of these. In the older forms large lumps of limestone are built up into an arch over the fire grate, the kiln filled up with smaller pieces, the fire is kindled and kept up for about two days. When the kiln is cold the lime is removed and the process begun again. In the other and more modern form the action is continuous, coal and limestone being fed into the upper part and the lime withdrawn below.

I take leave once again to emphasise the distinction between *limestone*, native calcium carbonate, and *lime*, the result of heating the limestone and expelling the carbon dioxide. In making lime 44 per cent. of carbon dioxide escapes and 56 per cent. of lime

remains. If, as is often the case, moisture is present in the limestone, the yield of lime would of course be under 56 per cent.

Lime, or quick lime (where the word *quick* has the same meaning as in the expression "the quick and the dead") is white and usually devoid of crystalline form. Its melting point is exceedingly high, but it can be melted and even boiled in the electric furnace (M.P. about $1,900^{\circ}\text{C.} = 3,452^{\circ}\text{F.}$).

When water is added to quick lime chemical combination takes place, slaked or slacked lime is formed and much heat is liberated. A temperature approaching 300°F. is, under favourable circumstances, reached and this often leads to a portion of the water being dissipated as steam. That some of the water has really entered into chemical combination with the lime is readily shown. If upon a weighed quantity of quick lime sufficient water is poured to make an obviously damp paste and the product then dried in an oven heated to or a little above 212°F. that part of the added water which has *not* combined with the lime will be expelled as vapour, but that which has entered into chemical combination will not be driven off. The resulting product, slaked lime, or, as it is called by chemists, *Calcium Hydroxide*, is a dry white powder. From 100 parts by weight of the original quick lime 132 parts of dry slaked lime are obtained, or 1 ton, 6 cwt., 45lbs. of slaked lime can be got from 1 ton of quick lime.

Slaked lime is slightly soluble in water and, unlike the great majority of substances, its solubility decreases with increasing temperature. The solution is known as lime water. A mixture of lime water and undissolved lime is called "Milk of Lime. [The solubility is about 3 parts per 1,000 of water, or more than 3 gallons of water are required to dissolve 1 ounce of slaked lime].

Lime water is used in medicine and in chemistry. It is alkaline in reaction, changing the colour of litmus from red to blue. It is valuable as a test for carbon dioxide, which causes it to turn milky.

At this point I would remind you of what I said a little earlier about the practical insolubility of calcium carbonate in pure water and its conversion into the soluble bicarbonate by excess of carbon dioxide.

A simple experiment can be shown to illustrate this. On passing a current of carbon dioxide from a "Kipp" apparatus into lime water, the clear liquid becomes turbid as the lime in solution becomes converted into carbonate of calcium, but the turbidity disappears and the liquid once more becomes clear as the stream of gas is continued. The liquid now contains calcium bicarbonate. Such a solution of bicarbonate of calcium is quite common in nature and is yielded by springs or wells in the chalk. The water is *hard*. On shaking it with a solution of soap it does not yield a creamy lather as in the case of pure water, but forms a curdy precipitate.

Hardness of this kind is said to be *temporary*, because, on boiling, the extra carbonic acid which keeps the calcium carbonate

dissolved is expelled; this carbonate is then deposited, generally as an incrustation or fur on the sides and bottom of the kettle or boiler. Another way of softening the water is by adding lime water.

Since lime is, in a sense, the cause of the hardness, some people find it difficult to see how water can be softened by adding more. The matter, however, becomes clear if we bear in mind

1. That lime in the absence of carbon dioxide is soluble in water.
2. That lime plus a single equivalent of carbon dioxide forms the insoluble carbonate.
3. That lime plus two equivalents of the dioxide forms the soluble bicarbonate.

If we have a sample of water containing this bicarbonate, to get rid of it we must convert it into insoluble carbonate. This we can do either

- a. By boiling out half the carbon dioxide, or
- b. By adding more lime to absorb it.

The precipitate which is obtained contains both the lime originally present and that which has been added in the form of lime water.

Our Bournemouth water supply is largely obtained from deep wells in the chalk near Wimborne. The water is very hard as it comes from the wells, but its hardness is materially reduced by the addition of lime.

We have seen that chalk can be broken up into lime and a gas and so is obviously not a chemical element; we now have to ask whether *lime* itself is an element or whether it also can be shown to consist of still simpler substances united together.

In ancient times *lime* was considered to be an element; it was indeed called an *earth* although it was distinguished from other forms of what was then supposed to be one of the four elements by the name *terra alcalina*. Suspicions that it might be related to some unknown metal in the same way that "calx" of lead (litharge) is related to metallic lead subsequently came to be entertained. It was not till 1807 that this guess was definitely proved to be well founded. In that year Sir Humphry Davy showed that lime was a compound of oxygen and a metal to which the name of *Calcium* was given. Nearly 100 years elapsed, however, before a method of obtaining calcium at a reasonable price was devised. This was at last done, and the price sank in 1905 from £9 to eighteen pence per ounce, and, before the outbreak of the war, it could be got for less than 6d. per ounce.

The method now employed consists in the electrolysis of fused calcium chloride to which a little calcium fluoride is generally added.

The metal is fairly hard, has a specific gravity of about 1.6 and a melting point of 800° C., or 1472° F., much higher than that of zinc, but considerably below that of copper. It acts slowly

upon water, setting free hydrogen gas and being itself converted into slaked lime.

There are a great many compounds of calcium besides those already mentioned, and I purpose giving a few particulars concerning a small selection of these.

Lime is not the only known compound of calcium and oxygen. When hydrogen peroxide is added in excess to lime water a precipitate is obtained which consists of a hydrate of *Calcium Dioxide*. By collecting, drying, and gently heating this precipitate the combined water is expelled and the pure dioxide results. On the large scale it is prepared by other methods. It contains 44.4 per cent. of oxygen as against the 28.5 per cent. present in lime.

Calcium can combine with hydrogen; the compound known as *Calcium Hydride*, or commercially as *hydrolith*, is formed by heating the metal in a current of hydrogen gas. It burns brilliantly, especially in oxygen, and is readily attacked by water, an ounce of the solid compound yielding about one cubic foot of hydrogen, half of which comes from the water.

An interesting natural compound of calcium is the fluoride, long known as fluor spar, the Blue John of the Derbyshire Caves. The name *fluor* is from the Latin *fluo*, I flow, the mineral having long been used in the treatment of metallic ores to increase the fluidity under the action of heat of stony substances that could not otherwise be easily melted. The vocabulary of optics owes the word "fluorescence" to fluor spar, its property of becoming luminous when heated having been observed as far back as 1677.

Calcium Chloride, which must not be confounded with the very different substance known in commerce as *Chloride of Lime*, is a very useful substance to the chemist. It is exceedingly soluble in water and readily absorbs water vapour, hence it is largely used in drying gases. It has been known since the 14th century, and an experiment which consists in mixing a concentrated solution of this substance with a strong solution of caustic potash or soda was described in 1686 under the name of "the chemical miracle."

The valuable disinfectant and bleaching agent known as *Bleaching Powder* or chloride of lime is made on a very large scale by the action of chlorine on dry lime. A simple experiment suffices to illustrate the right of this substance to the first of these names.

If a solution of bleaching powder is added to an infusion of logwood the deep red colour at once disappears.

Calcium Sulphide can be so prepared as to be luminous in the dark. Made by heating calcined oyster shells with sulphur it was formerly known as *Canton's Phosphorus*. The word phosphorus, or light-bearer, was formerly applied to any substance that glowed in the dark instead of being limited to a particular member of the family of chemical elements as is at present the case. The adject-

tive "phosphorescent" is still used in the wider sense. Luminous paint, luminous match boxes, and the like owe their light-giving properties to calcium sulphide.

When the oxides of such metals as iron, copper, lead, zinc, etc., are heated with carbon the oxygen of the oxide unites with the carbon to form one or both of the gaseous oxides of carbon and the metal is set free. Lime, the oxide of calcium, behaves differently. At the temperatures obtainable in ordinary furnaces no action takes place, but under the fervent heat of the electric furnace the case is different. Part of the carbon combines with the oxygen of the lime, giving carbon monoxide, and a further portion of the carbon unites with the calcium, so that the solid product of the reaction is not the metal, but its *carbide*. This, when quite pure, is colourless, transparent and crystalline, but the commercial substance is greyish black owing to the presence of numerous impurities. When it is treated with water acetylene gas is evolved, used, as everyone knows, as an illuminant, on the small scale for bicycle lamps and on the big scale for country houses, churches, etc., which are remote from gas or electric works.

A further use of calcium carbide is of great and increasing importance. Heated in nitrogen a new compound called *Calcium Cyanamide* (CN.N Ca) results. This is used in the preparation of ammonia, of the cyanides and other compounds of nitrogen, and as a fertiliser.

Just as calcite, Iceland spar, marble, chalk and limestone are naturally occurring forms of a single chemical compound, so Selenite, Alabaster, and Gypsum consist of another very important calcium compound, the sulphate. For the benefit of those who have not studied chemistry I may say that whereas *Calcium Sulphide* is a compound of calcium and sulphur only, *Calcium Sulphate* contains these elements together with a large proportion of oxygen, the ratio of sulphur to oxygen being the same as in all other sulphates and as in sulphuric acid. This substance occurs in nature as anhydrite, which has no combined water, and as ordinary gypsum which does contain water.

The sulphate is slightly soluble in water and is often present in natural waters. Water containing it is *hard*, i.e., it does not lather freely with soap, and hardness due to this cause is called *permanent* since it is not removed or diminished by boiling. For washing and such-like domestic purposes this kind of hardness can, however, be got rid of by the addition of a suitable quantity of washing soda, but water thus softened will contain sodium compounds and would not be improved for drinking.

To return to the water chemically combined with the calcium sulphate in gypsum. The chemical formula $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ indicates that 2 molecules of water are present to each molecule of the anhydrous, i.e., waterless, sulphate. This proportion is slightly under 21 per cent. of the whole. By strongly heating the gypsum all the water is expelled and the residue is not only much less

soluble in water than the original gypsum, but only very slowly takes up water to form the original compound. If, however, the gypsum is only gently heated a different result is obtained. Three-quarters of the water only will now be expelled and the product, still containing about 7-8 per cent. of combined water, is known as *Plaster of Paris*. This is more, instead of less, soluble than the original gypsum and when mixed with water a firm and solid mass is soon formed consisting essentially of long thin crystals interlaced.

This is, perhaps, a convenient point at which to refer briefly to *mortar*. Lime is slaked and made into a paste with which sand (three or four parts to one of lime) is then thoroughly mixed. Let us follow out the chemical aspect of the business. Chalk or limestone taken from the quarry was converted by heating in a kiln into calcium oxide or quick lime, 44 per cent. of carbonic acid gas being eliminated in the process. This lime has been slaked and thus converted into the *hydroxide* and the wet and plastic mortar which the bricklayer manipulates with his trowel gets stiffer as the excess of water evaporates. It is also left in a porous state through which air can circulate. Now air contains carbonic acid gas, and this is gradually absorbed by the lime. As time goes on a greater and greater proportion of this is reconverted into the substance from which it was in the first case made, namely, calcium carbonate. A hard and crystalline mass thus results. The process is slow and after the lapse of years, possibly of centuries, some lime may remain uncombined. The sand and lime also act upon each other to a small extent, but, even in very old mortar, the proportion of silicate, as the compound of lime and sand is called, is quite small, so that the function of the sand is mechanical rather than chemical.

Hydraulic mortars which will set under water have been known from ancient times. They are made from limestones containing a small proportion, say 8 per cent., of clay, or by mixing good fat lime with a proper quantity of a suitable silicate.

Cements differ from hydraulic mortars inasmuch as they contain no free lime. They are obtained by calcining limestone mixed with clay. These materials are ground together and the mixture, after drying, burnt with the aid of coke in proper kilns. The carbonic acid of the limestone is entirely expelled and the resulting lime acts upon the clay, forming silicate and aluminate of calcium. The *clinker* drawn from the kiln is broken up and ground to a powder. When this powder is mixed with water and left at rest it stiffens and continues to get harder and harder for many months. Nothing but water is required and this is completely absorbed. The chemistry is quite different from that of ordinary mortar, there being no absorption of atmospheric carbonic acid.

The dry cement consists essentially of a mixture of aluminates and silicates of calcium. When water is added the calcium compounds are decomposed, lime being set free; this lime reunites with

the silica, alumina, and a portion of the water to form a mass of interlacing hydrated crystals. The cement sets long before the formation of the crystals is complete, but the hardness increases as more and more of them are formed.

Calcium Phosphide is made by the direct action of phosphorus upon heated lime. When treated with water a spontaneously inflammable gas, called phosphine, is produced.

Calcium Phosphate contains oxygen as well as calcium and phosphorus. It is an important constituent of bone and occurs in apatite and other minerals. It is the source from which phosphorus itself is obtained.

Within the limits of a single lecture only a brief account of the chemistry of calcium can be given. My aim will have been attained if this sketch should prove a useful introduction to the other lectures of the series.

II.

The Geology of the Local Chalk.

By W. MUNN RANKIN, M.Sc., B.Sc.

(Read before the Geological Section, February 18th, 1915.)

CHALK is the limestone most generally known in the South of England, where several ranges of downs radiate eastward and southward from Salisbury Plain and terminate on the coasts in the magnificent white cliffs, which give our country one of its earliest names. The chalk forms the rim and floor of two wide basins, the London Basin and the Hampshire Basin, which between them comprise the whole country lying to the south-east of a line roughly drawn from the Wash to Bridport in Dorset, excepting only where they are separated by the denuded Wealden anticlinal arch and its small counterpart the Kingsclere arch; comparatively small areas in the Isle of Wight and the "Isle of Purbeck," which lie to the south of the chalk scarps must also be excluded. In our own district the downs form most of the high land; Cranborne Chase links up the downs about Salisbury with the Dorset Heights, which form the highlands of Mid-Dorset; these last turn eastward and continue as the narrow ridge of the backbone of Purbeck, and end at the coast in the cliffs of Handfast Point, which look out across the Bay to the chalk of the Needles and of the Isle of Wight much as the Culvers at the other end of the Vectian chalk range look up Channel.

The Chalk of England now lies wholly south of the escarpment previously mentioned, except for the outliers in Devon and the extensions to the north which form the Lincolnshire and Yorkshire Wolds. There is little doubt, however, that chalk formerly covered all England and Wales, with the possible exception of the higher peaks of the west and north, as well as much of the low-

lying parts of Scotland and Ireland. Chalk still occurs in County Antrim, where it has been preserved from the complete denudation of the rest of Irish deposits by being covered in middle Tertiary times by sheets of basaltic lava. Patches of cretaceous rocks occur also in the Isle of Mull, and a fragment of chalk, with characteristic fossils, has been preserved in the plug now exposed by denudation, of a Tertiary volcano in Arran.

Chalk was deposited in a wide sea, which at its greatest extent had its shores to the west on an ancient land of which Ireland and the Hebrides are only relics, its southern shores were in what is now Central France and its eastern in the middle of Germany. In the early times of the Cretaceous Period the crust of the earth in this part of the globe gradually sank and various distinct formations of rocks were laid down during the different phases. First the Weald Clay accumulated in a wide freshwater lake which was formed above the sinking deposits of the Purbeckian formation; this was followed by the sands and silt of the Lower Greensand as the sea burst in and deepened, and these in their turn were covered by the fine blue clays of the Gault and the glauconitic sand, often richly calcareous, of the Upper Greensand. The crust of the earth hollowed to still greater depths, and in these the calcareous deposits of the Chalk accumulated. The conditions throughout the period of deposition of the Chalk were on the whole remarkably persistent. A closer study of the fossil contents and the mineralogical composition of the Chalk, however, shows that the period was marked by several distinct physiographic stages which corresponded to various depths as the floor of the sea underwent elevation or subsidence.

The Chalk has long been divided into three main sub-divisions of a petrographical character; the Upper Chalk with Flints (the Senonian of Continental terminology), the Middle Chalk (the Turonian), and the Lower or Grey Chalk (the Cenomanian). At the base of each of these three divisions there is a more or less well marked bed: the "Chalk Rock" beneath the Upper Chalk, the "Melbourne Rock" (at the base of the Middle Chalk), and the so-called "Chloritic Marl," forming the basement bed of the Chalk as a whole. Locally the Chalk Rock and Melbourne Rock are not characteristically developed. The Chloritic Marl varies both in character and in horizon with reference to the Upper Greensand as between the Isle of Wight and Dorset, in places resting without any sign of unconformity on the Upper Greensand, while elsewhere containing many derived fossils and rolled fragments.

Another, and more trustworthy, manner of division, the paleontological, is based on a sequence of zones which are each characterised by some particular species of cephalopod or echinoderm. The type species of the zone is one which in some way distinguishes it from others, as being particularly abundant in it or wholly restricted to it, or representative of a small but constant assemblage of species confined to it over a wide area. It is thus

possible to determine the horizon of the chalk in any small isolated pit by its included fossils. The zonation of the Chalk received adequate attention from Professor Barrois, first in France, where wide downs form the borders of the Paris Basin, and later from him in our own country. The work of others, particularly Dr. Rowe, has confirmed the usefulness of the method and added not merely many details to the chalk fauna, but also considerable knowledge of the conditions under which the various divisions and beds of the chalk were deposited as well as of the steady flux of evolution which affected species during the vast period required for its accumulation. The best localities for the study of the zonation of the Chalk in our own neighbourhood are the cliffs to the west of Lulworth Cove and the cliffs near Freshwater in the Isle of Wight.

The Lower Chalk (Cenomanian) is composed of (i.) the Chloritic Marl at the base, (ii.) Chalk Marl with *Ammonites varians*, and (iii.) an upper or grey marl with a well marked Belemnite Marl near the top. It was apparently deposited in a sea which gradually deepened to 270 fathoms. The waters were affected by the silt carried down from the ancient Europe by a river which emptied to the south-east of the basin. The Dorset Lower Chalk seems to have been out of the way of the main currents from this river, for it is comparatively pure limestone, attaining a thickness of 149 feet at Ballard Point and rather less at Lulworth. It may be easily seen at West Nothe, Durdle Door and at Compton Bay, in the Isle of Wight. The western shores of the Lower Chalk sea were probably against the highlands of Devon and Wales.

The Middle Chalk (Turonian) follows the Lower Chalk without a break, and was laid down at the still greater depth of 500 fathoms in a sea which probably extended well over what is now Ireland and Scotland. The chalk consists of a fine sediment of shells of Foraminifera and contains between 96 and 99 per cent. of carbonate of lime. Two zones are distinguished—the lower of *Rhynchonella Cuvieri*, in which the Melbourne Rock is locally feebly developed, and the upper of *Terebratulina gracilis*. Locally it averages 100 feet, and can be easily made out about the Man-o'-War Cove.

The Upper Chalk (Senonian) is the thickest and most characteristic, and is best known as the chalk of the Downs. It shows locally six chief zones, which are distinguished from below upwards as the zones of *Holaster planus*, *Micraster cor-testudinarium* and *Micraster cor-anguinum*, forming the "Micraster chalk" and Marsupites, *Actinocomax quadratus* and *Belemnite mucronata* forming the "Belemnite chalk." Bands of flints occur in all zones. The Micraster Chalk was laid down on a steadily sinking floor. At the greatest depth of some 650 fathoms the purest chalk, that of the Marsupites and Actinocomax zones, was deposited. After this stage the floor was elevated and the *Belemnite mucronata* zone accumulated. Further east, as in Norfolk, higher zones have been preserved, which correspond to comparatively

shallow waters, while in Belgium and Denmark inshore deposits remain. The Upper Chalk of Ballard Point totals some 1,050 feet, and in the Isle of Wight 1,130 feet. Good localities are east and west of Lulworth Cove. Inland the different zones may be distinguished, but with greater difficulty than on the coast, in the downlands between the coast and Cranborne Chase.

Much happened between the deposition of the highest beds of the chalk still seen in this area and that of the Reading Clay, which now rests upon them in apparent conformity. It appears likely, in the first place, that many more beds were added, not only calcareous, but, as the sea became shallow, also clay and sand deposits. The uplifting of the earth's crust, which had now been going on for a long period, continued until the chalk was brought well above the sea as an elevated land. This uplift took the form locally of a vast monoclinal arch, which dipped southward towards Purbeck and the Isle of Wight. A similar, and possibly an even more complete, arching brought up the Kent and Sussex Chalk. During the last phases of its forming the sea floor the chalk would be certainly wasted by marine action and when it formed dry land atmospheric denudation would be operative. The result of this marine and aerial wasting, which would be particularly marked on the most elevated regions of the arches, is that over the greater part of the mainland chalk of the southern counties, the Belemnitella zone is absent, and, in places, even more than this is missing. In Purbeck and the Isle of Wight more remains, though certainly the Belemnitella zone is not complete.

After a while the well eroded Chalk surface again sank beneath the waters of the sea and in time was covered by the various early Tertiary deposits of the Eocene and Oligocene periods. It suffered fresh elevations even during these periods, once during the Bagshot stage and again during the Barton stage. The most considerable disturbances took place later—during the Miocene period. Then all over the globe considerable foldings of the earth's crust brought great mountain ranges into being, the Alps, Carpathians, Himalayas, and the ranges of America. Then also were folded the London and Hampshire Basins, the Wealden Anticline and those of Purbeck and the Isle of Wight, and the physical geography of the South of England generally more or less settled as we have it to-day.

III.

Calcium and its Compounds from a Geographical Standpoint.

By W. J. WOODHOUSE, A.C.P.

(Read before the Geographical Section, February 20th, 1915.)

CALCIUM has its own distinctive character and personality. Geographically this is prominently manifest in the economic and topographical features of a country consisting of calcium

formations. Calcium occupies the fifth position as regards relative abundance amongst the rock-forming elements in the earth's crust. Locally we are bordered on two sides by masses of calcium rock, whilst to the north the whole Hampshire Basin is fringed with chalk. Calcium is distributed in various forms throughout all fertile soils. Owing to the solubility of its carbonate in water containing carbon dioxide, it is common in rivers and springs. Bones of animals, shells of birds' eggs and shell fish, and ashes of many plants contain much calcium.

Fortunately in England, iron, coal and calcium occur almost within the same area, and this is largely responsible for our prominent position amongst the world's producers and manufacturers. Many cities owe their very existence to the presence of these three minerals. The great value of calcium to such districts is that it supplies, close at hand, a suitable flux for use in the smelting of iron.

Limestone rocks afford excellent building and paving material though various grades and qualities differ in degree of durability and other qualifications. Dolomitic Limestone, Mountain Limestone, Purbeck Limestone and Marble have assisted in erecting and beautifying a large number of our most prized and valued national edifices, and as such have contributed to special industries, e.g., those of quarrying and cement manufacture in the limestone areas. Portland and Swanage practically owe their existence to this cause, whilst, owing to modern invention and commerce, equally notorious centres, such as Arne, have fallen to decay. Such facts are strong indications of the inter-relationship of productions and commerce which literally make one aspect of geography, viz., that of commercial geography. Not only so, but the abundance of building material stereotypes the scenery of the landscape in the same manner. In limestone districts, for example, in Swanage, the prevalence of stone in architectural work is very prominent and produces an unique character in the scenery. "Rubble" walls are only associated with such spots as Swanage and the Pennines. Chalk, too, usually contains flints in great abundance. Flint as a building stone characterises the scenery of such a district. Thus in Kent, Norfolk, Essex, and the Eastern Counties a type of flint architecture is common and is not met with elsewhere. From this localised and special trades have sprung up, notably the flint knapping of such places as Brandon.

The great limestone and chalk escarpment traverses the country from roughly N.E. to S.W., forming an almost unbroken belt from the mouth of the River Tees to the Isle of Purbeck. The whole district is distinctly characterised by scenic and productive qualities completely its own. Generally it is the boundary between the metallic wealth of the mines and the finest agricultural land of our country. It is worthy of note that coal and iron are scarcely to be found on the east of this great escarpment, although to the west of it both are very abundant.

The sedimentary origin is clearly marked in both chalk and limestone and this gives a characteristic appearance of strata in the calcium rocks which is typical of itself alone. This horizontal bedding, however, is not indefinitely maintained. Volcanic action and earth movements have produced foldings and crumplings in the chalk whereby the strata have been tilted to every degree of obliquity. The Ballard Down fault is an excellent illustration of this.

The history of chalk definitely belongs to the study of geology, but for purposes of geography it is well to bear in mind the variety of chalk due to marine infusoria and that due to innumerable corallines where no trace of organism can be found. There is yet a metamorphic form common in limestone areas in the nature of stalactites and stalagmites. These are entirely due to the solubility of chalk and consequent evaporation of the solvent whereby the soluble constituent is deposited in a variety of icicle-like forms, such as is to be seen in the caves of Cheddar in the Mendips. Occasionally the crystalline form of calcium carbonate (calcite) results and the chalk cliff itself may be richly impregnated with crystals of Iceland spar or calcite. Much calcite of this description exists in the Purbeck limestone and chalk. The formation of this variety of crystal is evidently assisted by earth crumpling and by internal heat.

In this connection, viz., of chemically formed calcium rocks, one must scarcely forget the feature of calcium strata known as "petrifying springs" common at Matlock and other places. Rich deposits of chalk are laid upon objects subjected to the influence of the calcium-charged waters. Many of the chalky casts of bivalves found at Studland are the result of similar continued action and the fossil forest of Lulworth has almost identical formation. The volcanic areas are not without the geographical interest associated with calcium. Hot springs and geysers abound, containing carbonate of calcium, and the water of these passing over large areas of land covers the soil richly with beds of "tufa" or travertine so familiar a scene in the landscape of Iceland, Rome, and Naples.

The coral polype or zoophyte is also responsible for other unique calcium formations arbitrarily graded as "fringing reefs," "barrier reefs," and "atolls." Our own locality, and in fact our own islands, are almost free from present actual coral formations.

Coral reefs produce specialised geographical features and are peculiarly isolated patterns of land formations consisting almost entirely of carbonate of calcium derived from the coral polype. The coral polype belongs to the same class of organisms as the sea anemone, the gelatinous, flower-like creature common in rock pools around the coast. They extract the calcium carbonate from sea water and deposit it in a cylindrical body. These polypes multiply by budding, in this way the colony increases. As the polypes die their soft portions decay, whilst the hard calcareous skeletons remain to form coral rocks. The creature is extremely

fastidious. They can only live in warm water, and temperatures below 68deg. F. are unsuitable, thus they are consequently confined to tropical seas. Moreover they do not thrive below a depth of about 100 feet, though their existence is possible up to about 150 feet.

With the corals live a number of other lime secreting organisms, including calcareous seaweeds, and sponges and the like. Three types of coral reefs can be identified.

(a) The fringing reef, where the deposits of limestone form a fringe round the coastline; occasionally a small channel separates them from the mainland. Examples occur in the Sandwich and Fiji Islands.

(b) Barrier reefs run parallel to the coast and are separated from it by a wide and deep channel, which is often navigable and which frequently provides an excellent natural roadstead. The best example is undoubtedly the Great Australian Barrier Reef, which stretches roughly 1,250 miles along the coast of West Australia and varies in width from 10 to 90 miles.

(c) Atolls are circular reefs, containing apparently no land centre, but enclosing a sheet of shallow water called a lagoon. Usually there are one or more channels into the lagoon, which are open to the scour of the tides.

Waves and currents bring material to form soil, and fragments of the reef are detached by the waves and thrown as a cement upon the rest of the reef, thus assisting in forming a compact mass.

Seeds of trees and other plants are brought by currents and by birds and the islands become covered with vegetation. The palms are now almost natural inhabitants of the atoll.

In all types of reefs the constructive agency is most completely manifested upon the sea-side of the reefs, evidently on account of the greater abundance of food and of oxygen.

The mode of formation of coral reefs was explained by Darwin while naturalist on "H.M.S. Beagle." Taking into consideration the fastidious character of the polype he concluded that the coral rock must have been carried down by subsidence of the land, whilst the ring of coral continued its upward growth. Ultimately the island became totally submerged and the fringing reef became an atoll.

Sir John Murray, of the Challenger Expedition, has a rival theory as he points out that many atolls occur where land is actually rising. He is of opinion that every atoll is built upon a submarine mountain. Accumulations of muds, ooze, etc., gradually raise it to the requisite height. Then coral polypes settle in colonies and raise a table of coral. The question of food supply and oxygen determines the production of a ring, which rises to sea level and is carried above that level by the rising mountain. The polypes of the interior degenerate and die out while the outer circumference continues activity.

Both theories no doubt account for some of the cases. Dar-

win's theory is doubtless true in some and Murray's apparently more lucidly explains others.

Deep borings made on the atoll of Funafuti under the directions of the Royal Society revealed coral rock at the foundation of an atoll, at a depth of 1,000 feet below the level at which these animals can live, which clearly indicates a fall in the ocean bed, whilst on the other hand many borings are found to be less than 120 feet. The matter of formation is still under investigation and atolls have been referred to as "garlands laid by the hand of Nature on the tomb of departed islands" (Duke of Argyll).

The "white cliffs of Albion" is a phrase which has endeared itself to the heart of every Englishman and the thrill is most impressive when homeward bound after a season of absence.

The peculiar jointing of chalk and limestone call for a little attention since the peculiarities of jointing and bedding are quite unique to the series and lend a landscape picture pertaining to chalk alone. Originally in common with sedimentary rocks the strata were horizontal and in places the horizontal layers are well preserved. Earth movements, which are almost continual owing to slowly radiating heat, produce wrinkling by which folds are prepared in a manner analagous to the shrinking of an apple and the consequent waving of the skin. The lateral pressure, exerted by continual shrinkage, applied to the sedimentary nature of the laminæ in chalk, causes secondary cracks and fissures to assume vertical directions and cracks are thus produced which segment the chalk into almost cubical blocks. This is markedly seen in the stacks at Swanage and in Old Harry. The cubical nature of segmenting is inherent in the chalk and is partly the cause of the vertical faces of chalk cliffs. The cliffs of limestone are similar in appearance to the chalk, but the cubes are larger and bolder than those of chalk, as for example the cliffs at Tilly Whim.

Fissures of a larger nature are frequently due to insecure foundations or the slipping on a lower bed upon which the chalk rests. Excellent examples are to be found of this type of fissure near Sandsfoot Castle and Bow and Arrow Castle on the Isle of Portland.

Chalk cliffs present, as a rule, a vertical front to the sea. This follows upon the nature of its jointing and bedding. Portions which become detached through weathering leave a front parallel to the original front, and thus perpendicularity is ensured as the cliffs weather and fall away.

Chalk stacks, too, are a special feature of chalk. Locally two familiar landmarks of our bay and coastline are the Needles and Old Harry. These stacks, which have been severed from the mainland by the continual bombardment of the sea, are left ultimately as isolated pinnacles when the less resistant material has been carried away. They have thus been chiselled by nature out of the solid mass.

Contrast for example the scenic effects of the limestone cliffs of Tilly Whim, the chalk of Ballard Down and the sand of

Bournemouth Bay. The stern perpendicularity of the two former stands in marked relief against the broad sweeping bend of coastline in the last. When the sea broke through the connecting ridge of chalk between the Needles and Old Harry the soft sandstone rapidly eroded and a wide regular bend of coastline was carved by the subsequent set of the currents and tides.

Great regularity of coastline is common, too.

If the chalk coastal areas of our own islands be examined it will be found that there is considerable parallelism of the contour lines in these areas and the general direction of parallelism is along the coastal outline. In the regions of the limestone and chalk situated inland, screes are very common and occasionally along the shore-line where the lower formations fringe the coast the debris occurs as screes on a platform in front of the limestone. An excellent illustration of this is to be found at Portland and under the heights of St. Alban's Head. Screes, however, are not common on our chalk coasts as in most places where they occur the water is deep, and the chalk rises directly out of the sea. The chalk escarpments present some similarity to a sea coast and have occasionally been taken as sea cliffs. If the chalk escarpment were a sea cliff it must not merely resemble a cliff, but it must be a chalk cliff. In a few instances this appears so, but, as pointed out before, a chalk coast is a fairly straight line, while the chalk escarpment is freely intersected by coombes and valleys. The shore-line, too, must follow the sea level, but the base of chalk escarpments often rises and falls with more or less gentle slope. The land often rises in elevation behind a chalk cliff, but in the escarpments it almost invariably falls in altitude. Further, while coasts frequently pass from one geological formation to another a true escarpment always keeps to one formation.

The scenery of a country greatly depends upon its geological structure and the arrangement of the rocks on the earth's surface. Thus the type of scenery characteristic of Broads or Fens is closely allied to that of Holland in appearance, whilst the craggy crests and spires of the mountains of Wales resemble those of Switzerland, and between these two great types one meets with gradations of picturesqueness, each variety possessing detail peculiar to itself.

Limestone regions are among the fairest of our own fair country. The elevated and invigorating uplands and moors are mottled with masses of grey bare rock seamed deep with clefts and fissures, and in the cool shade of these steep cliffs are to be found carpets of bladder fern or hart's tongue growing in profusion along the lower channels of the scanty water supply of these areas. Along the top of the cliffs and downs are stretches of short, crisp grass, which afford ample pasturage for sheep. Small streams of water spring from cracks and crevices, and make their way downward in clear brooks and cascades through deep narrow gorges of a somewhat miniature type.

The material on which deuning agents work plays an important part in the shaping of geographical features of the land-

scape. Limestone usually weathers into broad uplands where solitude reigns on often absolutely treeless heights. The characteristics of the chalk are somewhat similar. Trees are not common, but the solitude of such heights is materially assisted by the velvety grass which covers the scanty layer of soil. The larger valleys are practically waterless, and everywhere show flecks of dry white rubble through the thin coating of soil.

A view over the broad plains gives little suggestion of hollows or gorges, and in travelling the country we do not become aware of them until we stand upon the very brink of their steep slopes.

Peculiarly enough, although the valleys are waterless, they show evident signs of water action. Streamlets on limestone moors not infrequently suddenly disappear into "swallow holes" and continue their courses underground through crevices, joints and caves of which the limestone is full, to emerge again into open day and continue their courses to the sea. The regions of Cheddar and the Pennines contain numerous examples of these, and good examples are to be found in Belgium in the River Styx and the River Lesse, the details of whose underground courses even to-day are not fully ascertained.

Quarries form a well-marked feature in limestone scenery. The stone is worked both for building and for road ballast. The work of building many of our finest cathedrals was facilitated by the supply of stone from limestone regions. Purbeck furnishes two or three varieties of excellent stone in the shape of its marbles, which are highly prized for decorative architectural work. Chalk hills or, as they are more familiarly termed, "downs," weather much in the same way as limestone, but being softer and more pulverulent, usually take the form of smooth rolling hills. The nature of the country and the regularity of the various gradients, no matter from which side the down is approached, is well brought out by reference to an orographical map. Limestone and chalk are then brought markedly in contrast by the form taken by their contours. Three suitable regions might be taken as typical:—(i.) The area of the Downs, which is distinctly soft chalk; (ii.), the Mendips or Mid Pennines, as illustrative of mountain limestone; and (iii.) the South Western portion of the Southern Uplands, which are typical of volcanic regions. Taken in succession the map shows a marked increase in the tendency to irregularity of the contours. In the Downs the almost parallel nature of the contours is clearly characteristic, whilst in proceeding from limestone to volcanic areas the irregularity is again markedly increased. William Smith, the Father of English Geology, says: "I could see that the Wolds contained chalk by their contour."

Caves are of common occurrence in calcium areas, and many of these give rise to rivers. As a rule, however, the water supply is distinctly intermittent and the outlet usually in the shape of a syphon. As the sea cuts away the front of the cliff these are often left exposed to the action of its waters and become the

homes of countless numbers of gulls, which seem to have a distinct preference for dwelling in chalk cliffs.

I have already referred to sheep rearing as characteristic of chalk downs. Many of these districts have become world renowned in their production of first class breeds. The South Downs, The Cotswolds and The Leicesters have become particularly famous. Subsidiary industries naturally associated with the raising of sheep have found a home and a workshop in the surrounding districts. Thus it is that the chalk formations are intimately connected with the manufacture of flannels and tweeds. In this connection it is well to note the severance of the rearing of sheep and the rearing of cattle. While there is much in common with the two industries, chalk does not supply the necessary water for cows. Thus it is that pasturage for sheep and cows is distinctly selective. Usually that suitable for cows is at a lower level or in the river valleys, and this in its turn earmarks distinctly the dairy farming of Cheshire and Devonshire from the rearing of sheep.

From the hygienic standpoint chalk and its overlying gravels are distinctly pre-eminent for the invalid. The dry soil and the brisk fresh air have been the means of restoration of health to countless numbers of sufferers. Sanatoria for chest complaints are common to chalk and gravelly formations, whilst situations on or near the chalk have proved successful training grounds and military camps. The knowledge of such matters, although not distinctly formulated by them, was undoubtedly uppermost in the mind of early man when he planned his village or encampment, as evidenced by such remains as Stonehenge and "dewponds" so familiar in the Downs.

The rolling nature of the downs and the boldness and regularity of their slopes, together with the contrast between the white chalk and the green turf have given the idea of cutting gigantic designs and figures upon the hillsides of the downs, such as to-day are to be seen at Weymouth, The Vale of the White Horse, Old Sarum and elsewhere.

The chalk cliffs from which our island has derived one of its names and which are regarded as typically English form a very small part of our English coastline. The actual areas are those from (1) Speeton to Bridlington; (2) part of the north coast of Norfolk; (3) the Isle of Thanet; (4) from Deal to Folkestone; (5) part of Sussex; (6) part of the Isle of Wight; (7) part of Purbeck. These are purely white chalk, elsewhere we have grey cliffs of mountain limestone. As the whole of the successive early invasions of Britain came from the East and South, the name was justifiably applied since all these areas occur within these limits.

Our mountain limestone is distinctly marked by glacial striations, and this has assisted towards our national fertility in no small degree. The soil and plant life need lime. Hence where this is lacking the deficiency is artificially made up by sowing the land with lime. The general tendency of the glacial action was to

transport chalky matter over open clayey and heavy lands. The ice, too, in passing over a variety of rocks has ground them up and mixed the waste together. The open claylands have been impregnated with chalk, and a great difference in fertility is noticed on the eastern side of England in the regions north and south of the Thames. Some of the finest wheat lands have been produced by the mixing of the soils, whilst rain, wind and frost have furthered this action.

The water supply of calcareous areas is further noted for a specialised formation which gives rise to Artesian Wells. The water of London is mainly derived from this source. Previously the water supply for the City was taken from the Thames above Staines. This is now inadequate, and London derives the greater amount of its water from the chalk by Artesian Wells. The fountains in Trafalgar Square were some of the earliest, if not the earliest, Artesian Wells in the country. The character of water from the chalk that add to its domestic use are its purity, clearness and free supply of air and carbon dioxide, whilst its great drawback is its hardness, which lessens its cleansing properties and increases its wastefulness in soap.

In calcareous areas springs often gush out of ground higher up the valley after heavy rains have raised the level of underground water, but with light rains, or during seasons of drought, the rivers dry up. This is singularly common along the Pentridge Downs and Salisbury Heights. After heavy rains springs frequently issue from irregular sources of this description and produce floods in limited areas. The chalky regions of England are comparatively waterless as regards river courses. A full map of the river basins of England clearly shows the course of the chalk and limestone across England by the diminution in the number of affluents to the principal rivers and streams. Within these very pervious areas the winter rainfall collects to form springs, whilst the summer rains freely evaporate owing to the porosity of the soil.

In this connection it is worthy of note how few rivers cross the chalk. There is an almost total absence of gaps through the chalk, and nearly all our railway lines leaving London have been compelled to tunnel the chalk to get through.

Incidentally chalk was the means of establishing safety on the new railway line between Brockenhurst and Bournemouth. On the construction of this direct communication great difficulty was experienced in maintaining the gravelly cuttings and embankments. These were constantly undermined and were incessantly slipping away. Chalk was the means of saving the situation, dykes were dug and filled with chalk, and has proved entirely satisfactory, and the experiment has since been successfully repeated in many parts of the country.

The chalk is a present monument to Transmutation. Slowly, but surely, even that portion now above sea level is being ground down. Portions fall into the sea to be crushed to the finest mud and carried away by ocean currents to be absorbed by present

foraminifera for a repetition of shell building and, sinking to the floor of the ocean may rise again as towering majestic cliffs such as are our Island's pride.

IV.

Lime as an Agent in the Nutrition, Protection and Distribution of Plants.

By SIR DANIEL MORRIS, K.C.M.G., M.A., D.Sc., D.C.L.

(Read before the Botanical Section, March 25th, 1915.)

ONE of the commonest forms of lime is the carbonate of lime formed by the combination of the oxides of calcium and carbon. This constitutes the bulk of the chalk deposits and the mountain limestones. It forms, also, more than one-half of the magnesian limestones, and is present in varying quantities in calcareous sandstones (sand and lime), and in marls (lime and clay). Probably the majority of limestones are of organic formation; that is, they consist of the debris of the skeletons of a vast series of animals. Some of these animals, as in the case of the Rhizopods or foraminifera, that have made up the large masses of chalk, are very minute—in fact microscopic. Others, such as crinoids or star fish, and shell-fish, such as oysters, clams and molluscs generally are moderately large. Coral limestones are being formed at the present day over a large extent of the tropical seas, while globigerina ooze, which is continually accumulating in the abysmal depths of oceans, and will eventually become chalk, is the most widespread of modern calcareous formations. As will be shown presently, there are quite appreciable deposits of limestones that are entirely due to the action of plants.

Among limestones we may distinguish chalk as the earthy form, mountain limestone as the compact form, and marble as the crystalline form. The purest of all natural varieties of the substance which is the basis of all limestones are the beautiful crystals known as Calc-spar and Iceland-spar.

Carbonate of lime is easily dissolved in rain water in the presence of carbonic acid. When lime is present in water in quantity it causes temporary hardness. When such water is boiled, and the carbon dioxide driven off in bubbles, the lime is deposited in the form of "fur" in kettles and boilers; or when dripping from the roof of caves the deposits known as stalactites and stalagmites are formed.

As is well-known, when ordinary limestone or chalk is heated or burnt in a kiln, and the carbonic acid is driven off, we obtain commercial quicklime. This may be regarded as almost pure oxide of calcium. Usually when we speak of lime it is this oxide

is meant. When slaked by the addition of water the chemical union that is immediately set up gives rise to the development of considerable heat.

Another important combination of lime is the oxalate of lime. This is widely found in plants, and as it is largely concerned in the economy of plant life, we shall make further reference to it. In the meantime we may accept it as generally understood that all mineral substances, such as lime, potash, silica and others can only be introduced into plants after they are completely dissolved in water. The delicate root hairs that are in direct contact with particles of soil absorb moisture (or what may be popularly called soil juice) and the crude sap passes upward through the cell membranes into the stem and leaves. Afterwards when the various substances contained in the sap are fully elaborated into suitable food-material in the leaves, they then descend and serve to build up the structure of the plant, and maintain its several activities, including the ultimate production of fruit and seed.

Lime easily dissolves in water, and thus it is absorbed by the root hairs, and found in nearly all parts of plants. An acid that readily combines with lime, found plentifully, in such plants as wood sorrel and varieties of *Rumex*, also in rhubarb and various lichens, is the oxalic acid already referred to. It is probable that a large part of the lime found in the tissues of plants is precipitated by this oxalic acid and remains inactive. According to Sachs, "the chief importance of lime in plants must be sought in its serving partly as a vehicle for sulphuric acid and phosphoric acid in the absorption of food material; and partly in its fixing the oxalic acid, which is poisonous to plants, and rendering it harmless." Elsewhere Sachs states this in another form:—"Calcium dissolved in water is introduced into plants in combination with sulphuric acid as calcium sulphate. This when decomposed sets free the lime which combines with oxalic acid to form insoluble calcium oxalate. The sulphuric acid goes to form the sulphur which is used in the production of albuminous substances or proteids. Lime is therefore important to plants, inasmuch as it is a medium of transport of sulphur." It might be added that without the albuminous substances or proteids just referred to plants would be unable to yield the nutritive food-substances which render them acceptable sustenance for man and beast.

Lime Deposits in Trees and Coco Nut Pearls.

That lime in some form exists in the cells and tissues of plants can be abundantly proved. For instance, what may be regarded as excess deposits of carbonate of lime, have been found in the wood of a number of Dicotyledonous trees usually blocking the cavities of vessels here and there or sometimes forming more extensive accumulations entirely filling the cavities of vessels, fibres, parenchyma cells, etc., over considerable tracts of wood. Such deposits may be seen in heart-wood, or in knots, or in dead wood due to wounding. Examples of the species in which

carbonate of lime has been found to occur in this manner are the common elm, American nettle tree (*Celtis*), common sycamore, white poplar and silver birch. Carbonate of lime may also be found in the cavities in wood known as "windshakes." Mr. Valentine Ball, of the Geological Survey, found instances in India where deposits of limestone actually alternated with the ordinary rings of wood growth in the trunks of trees. Masses of such deposits of irregular shape, seven inches long by two broad, were found in trees six feet above the ground.

Perhaps the most interesting of all occurrences of lime in plants are pearls in coco-nuts. These were first described by Rumphius from the East Indies more than two centuries and a half ago. He not only drew up a careful description of them, with illustrations, but even sent a specimen coco-nut pearl in 1683 to the Grand Duke of Tuscany, who had it mounted in a ring. For a long period after this coco-nut pearls were only known locally to the Rajahs and Mandarins, who attributed all manner of virtues to these rare products. In 1887, Professor Hickson, F.R.S., now of the Victoria University of Manchester, announced in "Nature" his discovery of coco-nut pearls while exploring the Celebes. One of the specimens brought home by him is now in the Museum at Kew. I have been fortunate enough to see and examine two others. One in the possession of Mr. Streeter, formerly of Bond Street; this was finely engraved with Arabic characters. The other was the property of a lady living at Kew whose father had brought it from Singapore. An analysis of one of the specimens obtained by Professor Hickson proved it to be pure carbonate of lime and almost identical with that produced by the pearl oyster. Coco-nut pearls are either globular or egg-shape. The colour is pure milk-white. They are somewhat deficient in lustre as compared with ordinary pearls and rather harder. So far coco-nut pearls have only been found, or at least reported, from the Eastern tropics.

As naturally might be expected from what is stated above, carbonate of lime is found in the ash of most plants. Ash from the branches and leaves of the common yew growing in different soils have been analysed with the following results: Ash from yews growing on metamorphic rocks, such as serpentine, contained 16 per cent. of lime, on gneiss 30.6 per cent., and on limestone 36 per cent. It will be noticed that the ash from trees growing on limestone yielded more than double the amount of carbonate of lime compared with those growing on serpentine soils. This may afford a clue to the presence of the large deposits of lime found in the trees referred to above. It is not improbable that where soils are heavily charged with lime the roots take up a larger proportion of it, which is afterwards deposited in the tissues. Possibly the formation of pearls in coco-nuts may be due to similar circumstances. The largest proportion of lime found in the ash of any vegetable growth is met with in the stone-worts (*Chara*). According to Kerner this amounts to 54.8 per cent.

Continuing our investigations, we find lime occurring in fine granular deposits in the cells of living plants. Also in rounded grains in others. In the epidermal cells of the leaves of fig and mulberry trees and in hops are deposited clusters of very small microscopic crystals of carbonate of lime known as cystoliths. Nearly all other crystals found in plants consist of oxalate, not carbonate of lime. Those appearing like bundles of needles are known as raphides. Some of these are microscopically of large size and beautiful with perfectly formed crystalline surfaces. Such crystals are found in the cavities of cells in the leaf stalks of begonia and in the stem and root of the haricot bean. In lilies and aroids crystals of oxalate of lime in the form of raphides are found filling many of the large elongated cells.

It is interesting to note in the case of the calcium oxalate stored up in great quantity in the leaves at the end of summer that the throwing off of the foliage in the case of deciduous trees and shrubs must be really regarded as a method of removing waste materials and may be compared to the excretion of waste which occurs in animals. It is only the framework of empty cells—the dead envelopes of the living portions of the plant—which is thrown away. The valuable carbo-hydrates and albuminous materials—in fact everything which is of use to the plant, have already been conveyed from the leaf blades into the woody branches or subterranean root stocks and there deposited in places where they find a safe resting place and can survive the drought of summer or cold of winter unharmed.

Lime Dissolved and Accumulated by Plants.

There are striking instances where the roots of lichens and mosses by the exudation of carbonic acid have corroded and etched hard surfaces and caused rough and uneven depressions. There are chemical as well as mechanical influences at work. A growing rootlet penetrates wherever the merest particle of lime has been dissolved and accomplishes regular mining operations. Projecting particles of the carbonate not yet dissolved are separated by mechanical pressure of the roots from the main mass, and tiny loose fragments of the lime are to be seen, which are washed away by the next shower or else carried off as dust by the wind.

The roots of the higher plants also produce similar results. This may be proved by sowing seeds in a layer of sand on a polished slab of marble. The roots of the seedlings creeping closely in contact with the stone cause markings as though the latter had been etched. A solution of individual particles of lime takes place under the influence of the acid juice saturating the cell walls of the roots. Such markings are quite distinct and can be seen by the naked eye.

Still more striking is the accumulation of lime by the agency of water plants in streams and lakes. In water loaded with bicarbonate of lime a number of mosses become encrusted with

carbonate of lime. Usually they go on growing at the apical end, while the lower parts embedded in lime die off. In consequence the bed of the stream itself becomes calcified and elevated, and in course of time banks of calcareous tufa are formed which may attain to considerable dimensions. Banks raised in this manner are known which are no less than 60 feet in height. To construct them, mosses and other plants must have worked for more than two thousand years.

Numerous stone-worts (*Chara* and *Nitella*), the water-milfoil and hornwort, water-crowfoots (*Ranunculus*), and more especially pond-weeds, which grow in continuous masses in still inland waters, incrust their delicate stems and leaves with lime during the summer, but in autumn shrink away without leaving any trace of the mass of vegetation until the following spring. The calcareous deposits, however, are preserved, and, sinking to the bottom of the water, form a layer which year by year increases in thickness. Anyone who investigates the wastes of water in the shallow lakes of lowland districts will be convinced of the magnitude of the scale on which this kind of accumulation must take place.

As a boat glides over places where there is a luxuriant growth of lime-encrusted chara and horn-wort there is a creaking sound in the water like the snapping of dry sticks of birch wood. Great numbers of stone-worts are fractured by the boat as it strikes against them, and if one takes hold of the fragments they feel like a heap of brittle glass. Similarly amongst the pond-weeds (*Potamogeton lucens*) in particular the lime clothes its large shining leaves with a very stout uniform crust, which drops off in scales as the plant dries, the weight of which can be exactly determined in the case of each separate leaf. There is no doubt that in times past large lacustrine deposits of lime have been thus formed. The spore fruits of stone-worts and the nutlets of pond weeds found in them clearly show this.

Absorption Glands with Incrustations of Lime.

We have seen that the lime excreted on the leaves of certain hydrophytes or water plants falls away and accumulates at the bottom of lakes and streams. On the other hand, the lime is sometimes employed in protecting the pores or stomata and guarding against the too rapid evaporation of moisture. It is also associated with what are known as absorption glands on the leaves of certain plants exposed to dry conditions. Before discussing these I would first of all refer to water-collecting and absorbing structures generally. In the case of the teasel there are water receptacles which receive and hold water for weeks together. In such water there are found the remains of decayed earwigs, beetles and spiders, so that in such cases it is possible that the water, and some organic compounds dissolved in it, is susceptible of being taken up not only from the soil, but also by means of absorptive appliances on the stem and leaves. Again,

the rachis of the common ash is furnished with a groove on its upper surface which receives and absorbs moisture for several days after a fall of rain. On the under surface of the leaves of the alpine rose (*Rhododendron*) there are discoid glands sunk in little hollows. When drops of rain fall the water soaks, by the action of the hairs, to the under side of the leaf. It is then taken up by the glands and absorbed by the plant. As soon as the leaves become dry again the glands become covered with a dry crust, and they thus prevent too great evaporation. Absorptive cavities and cups are also found at the base of the leaves of the Aspen, but possibly the most remarkable are the structures adapted for absorption on the leaves of a group of saxifrages. In one species (*Saxifraga aizoon*) the leaves have little depressions upon their upper surface behind the apex. One of these depressions occurs in the middle of each tooth. In order to prevent the loss of moisture each depression is provided with an incrustation of carbonate of lime forming a stopper which fills the entire cavity. Further, the crust of lime is ingeniously held in place by a series of peculiar plugs. When rain or dew falls on a saxifrage the water soaks under the crust of lime and diffusing itself there is taken up by the absorption-cells at the bottom of the depression. In dry weather the crust is appressed to the cavity and impedes the evaporation of water. Somewhat similar incrustations of lime are found on the leaves of plants growing on the arid ground of steppes and deserts, but time will not permit of a detailed account of these.

Lime-loving and Lime-shunning Plants.

It has been long recognised that soils containing a comparatively large proportion of lime are remarkable for the presence of certain species of plants. This is within the common experience of field botanists everywhere. Examples of the lime-loving or calcicole species occurring on calcareous soils in this district are discussed by Mr. Munn Rankin and the Rev. E. F. Linton in the "Bournemouth Handbook of Natural History." Briefly stated, ash woods are characteristic trees in the chalk district in the south with natural beechwoods on the escarpments and valley sides. Other trees more or less associated on lime soils are the pedunculated oak. The smaller trees and shrubs forming the "shrub-layer" consist of the spindle tree, the blackthorn, various roses, briars, dog wood, elder and the hazel. What is known amongst ecologists as the "carpet" vegetation is a rich one, and contains sheets of the dog mercury, primroses, wood sanicle, violets and wild strawberry. The orchids, according to Mr. Rankin, "are perhaps the greatest botanical charm of the carpet association on chalk." "The grass lands (Mr. Rankin continues) have open downs covered with sheep pasture. The turf presents a great variety of colour according to the season. Early summer finds it decked with masses of the rich blues and heliotropes of the milkworts, the orange and yellow of lady's

fingers, and the rock rose and the delicate white of the squinancy-wort (*Asperula*). Later in the year the heads of the prettier thistles—the carline, the dwarf and musk—relieve the monotony of the grass-land.”

A few words may be added as to lime-shunning plants. The most common of these are the rhododendrons, azaleas, the heaths, and the broom. Wherever these are abundant it is certain that lime is absent. The reason why such plants are intolerant of lime is still in doubt. The roots of many, if not all of them, are covered with a mycelial mantle showing they belong to a group in which there is a physiological partnership with a fungus. It is not impossible that the corroding action of lime is unfavourable to the fungus. If so, the plant cannot obtain its supply of food in the usual way and dies. The subject of what is termed mycorrhizal symbiosis is too large to be discussed here; but it is now recognised that there is an important relation existing between the fungus-mycelium and the green-leaved tree or shrub which it provides with water and foodstuffs from the ground whilst it receives in return from its partner such organic compounds as have been elaborated in the green leaves above.

Use of Lime in Agriculture.

In the production of farm and garden crops lime is essential, and it exerts a three-fold influence. In the first place it is a direct source of plant food; in the second place, by its mechanical action, it unlocks and renders available the stores of inert food contained in the soil; and, lastly, it is valuable on account of its effect in ameliorating the texture of clays and rendering them capable of more successful treatment. As it is admitted that all crops require lime, a soil deficient in this mineral substance can never be a very productive one. It is, possibly, in its second character that lime performs its most important work, namely, by decomposing all kinds of vegetable matter in the soil and correcting acidity due to the presence of organic acids. Farmers and gardeners express this by remarking that “lime sweetens the soil,” because it makes the conditions more favourable for plant growth, and encourages the beneficial action of numerous micro-organisms. It is important, however, to bear in mind that lime does not supply the place of organic manures, but only renders that which is already present more easily available for the growth of crops. When used on light dry land like that in the neighbourhood of Bournemouth it tends to make the land drier, since it destroys the humus. Besides its many other merits, lime improves the yield and quality of crops. It destroys injurious insects and checks the growth of moss and weeds. Lime is regarded as the only cure for the disease known as “finger and toe” in turnips and cabbages, while it hastens the maturity of crops. It may thus be realised how various and important is the work performed by lime in increasing the production of all our food crops.

Mr. Mansell Pleydell, in his introduction to his "Flora of Dorset," bears the following testimony to the agricultural value of lime soils:—"The elevated tract of chalk land which nearly encircles the county is almost exclusively devoted to the cultivation of corn, roots, and forage, sustaining large flocks of sheep, the superiority of which gives the Dorsetshire farmer a pre-eminence in the agricultural world." The limestone districts in the North of England also afford favourable conditions for sheep raising. There is a breed of sheep in Westmoreland known as the "Limestone," and it is said not to thrive off its own geological formation. Horses are said to thrive better on limestone soils, and to develop plenty of bone and sinew. So, on the whole, the truth of the old proverb that "a lime country is a rich country," seems to be well established.

V.

Lime in the Service of Man: An account of some of the Applications of Calcium Compounds in the Arts and Industries.

BY HUBERT PAINTER, B.Sc., F.C.S.

(Delivered as a General Lecture at the Society's Room, April 24th, 1915.)

FOR the second time it falls to my lot to deliver the concluding lecture of a connected series dealing with the compounds of some one chemical element. Last year Silicon was the element chosen, this year Calcium has been selected.

I set about the preparation of this lecture with some misgivings, for, while a great number of substances containing or consisting of one or more of the numerous compounds of Calcium are used in the arts and industries, it must be granted that in some cases the Calcium is, if I may use the expression, only a junior partner. Apart from this I doubted, and still doubt, whether the applications are as numerous or as interesting as in the case of the Silicon compounds. Although, in the first lecture of the present series, I had an opportunity of dwelling upon the chemistry of the subject, I take the liberty of prefacing my account of the industrial application of the Calcium compounds by reminding you that the element Calcium is a somewhat hard metal of low density, i.e., low for a metal, of silvery appearance and of great chemical activity. It is never found in the free state in nature. Its principal oxide is known as Lime. This is a hard, white and very infusible substance which greedily absorbs water, yielding slaked lime. It also reacts readily with acids and acid-forming oxides, giving the various calcium salts. Neither quick lime nor slaked lime occurs

in nature as such; they are artificial products obtained by the action of heat, or of heat followed by the addition of water, on Calcium Carbonate. This, as the various limestones, occurs in immense quantities in the earth's crust as rocks of various degrees of hardness, and, in a state of solution, in many natural waters, waters of the ocean, of lakes, rivers and springs. It is with Calcium Carbonate that we may most conveniently begin our study of Lime in the Service of Man. I shall speak first of those uses and applications which depend on mechanical and physical properties and do not involve any chemical change. Calcium carbonate is, for our present purpose, best regarded as a compound of the second order, i.e., as a compound of two compounds, Lime and Carbon Dioxide. The latter is, perhaps, better known as carbonic acid gas. In 100lbs. of pure chalk or marble there are 40lbs. of calcium, 12lbs. of carbon and 48lbs. of oxygen. One third of this oxygen may be regarded as the more peculiar possession of the calcium, the remaining two thirds as belonging to the carbon. Although calcium carbonate is almost insoluble in pure water it can be dissolved by water containing, as even rain water does contain, some carbonic acid. Partly by this solvent effect of water thus charged and partly by the mechanical friction due to sand or stones carried by water in motion, limestone rocks are specially liable to contain hollows, caves and caverns, sometimes of vast extent. In some cases caves of this kind were used by mankind in early ages as shelters or habitations. A little more than a year ago Mr. Balch lectured before this Society on "The Caves and Cave-dwellers of the Mendips," and I need not say more concerning this early and widespread use of limestone. From such primitive habitations, for whose possession man must often have contended with mighty and ferocious beasts, we naturally pass to buildings properly so called. Amongst building materials those of calcareous origin occupy a most important place. Chalk itself has been used as a building-stone although it is usually too soft for the purpose. According to the *Encyclopædia Britannica* chalk compact enough to be used by the builder is quarried in Devonshire and known as Beer stone. But although chalk has but a very limited application in this particular respect the oolitic and other lime-stones furnish many most useful and valuable building-stones. Bath stone and Portland stone may be mentioned as examples. Some of these limestones consist, to the extent of 95 per cent. or more, of calcium carbonate, others contain considerable quantities of magnesium carbonate and are known as dolomites. The ancient castle of Conisborough, familiar to all readers of Scott's *Ivanhoe*, is built of dolomite, as is also much of York Minster. The Houses of Parliament furnish a modern example of a great building of the same material. St. Paul's Cathedral is of Portland stone. Marble, where obtainable with sufficient ease, is an admirable building-stone, but in most countries it is too costly for other than decorative uses. For

statuary it is, of course, of special value. The name "marble" may be given to any limestone which is sufficiently close in texture to admit of being polished. The beautiful lustre of statuary marble is due to the way it reflects light. This is able to penetrate a short distance into the stone, since the individual calcium carbonate crystals are transparent, and it suffers reflection at the surfaces of crystals lying at a deeper level. Amongst the most celebrated marbles are the following:—Pentelic marble was the material in which the ancient Greek sculptors, Phidias and Praxiteles, worked. The Elgin Marbles now in the British Museum may be taken as examples. Parian marble from the Isle of Paros was also used by the Greeks. Carrara marble from the Apuan Alps, an offshoot of the Appenines, was used by Michael Angelo and is a favourite of present day sculptors. Veined and mottled marbles, although unsuited for statuary, are much valued for architectural purposes. The markings may be due to the presence of fossils or to the infiltration of water charged with colouring matters, such as compounds of iron and manganese. Black marbles owe their colour to the presence of bituminous matter or other carbonaceous substances. Some stones technically known as marbles are stalagmitic in origin. The Algerian onyx-marble is one of the most beautiful of these. It was used centuries ago both in Rome and in Carthage, but the secret of its source was long lost; the quarries were, however, rediscovered in 1849. Marbles of similar character are found in Mexico and California. It was probably to marble of this kind, essentially calcium carbonate deposited from solution, that the name Alabaster was originally applied. The word now stands for certain valuable kinds of calcium sulphate, chemically a quite different substance. While speaking of marbles it may be well to refer to the ancient game known by that name. The little spheres now used for the purpose are made of clay or glass, but in the 18th century they were, sometimes at least, actually made of marble, chips of that material being rounded in a special kind of mill. Some were made in Derbyshire and other parts of England, but Nuremberg was the centre of the industry. The name "ally" or "alley" applied to marbles of superior quality as distinguished from the cheaper "commonies" is said to be a diminutive of alabaster. Readers of Dickens will remember the reference to "Alley-tors" in the *Pickwick Papers*.

So far we have only considered uses of native calcium carbonates which have undergone no preparation save that of cutting, sawing, or otherwise shaping; let us now go one stage further and consider means for separating from chalk the impurities it contains while not interfering with its chemical composition. Although chalk is mainly composed of calcium carbonate it usually contains a certain amount of what, for our purpose, may be described as grit. If the chalk be ground with water and the milky liquid poured off into another vessel, the grit will be left in the first vessel, the finer particles remain in suspension somewhat longer

and settle down in vessel number two. In this way "whiting" is made and this, mixed with size, constitutes the white-wash used for ceilings and for walls internal and external. A similar process to that by which whiting is made gives, when carried out with greater care, the "prepared chalk" of the druggist. This finds application in medicine and as a cosmetic.

Amongst minor uses of suitably prepared chalk may be mentioned the marking out of lawn tennis courts and the chalking of billiard cues. The whiteness and softness also render it suitable for writing on the blackboards of schools and colleges as well as for chalking up scores behind the door of the village inn. It is, however, the case that much of blackboard "chalk" is not really chalk at all, but consists mainly of another calcium compound, the sulphate already mentioned. The so-called French chalk also, with which our tailors make little marks on our coats when we are having them tried on, is not a true chalk, but a variety of steatite or soapstone. Precipitated chalk, much used as a dentifrice, either alone or with various additions, is an artificially prepared calcium carbonate.

Of the uses of chalk in agriculture our President treats in the lecture which he contributes to this series.

There are two other forms of naturally occurring calcium carbonate to which I must refer before passing to the second division of my subject. Coral is one of the forms of calcium carbonate of animal origin, and, like other varieties of this substance may be used for making lime. The precious coral is, however, the only kind that fairly comes within the scope of the present lecture. This precious coral comes from the Mediterranean and has been highly prized from the most remote times both for its beauty and because various medicinal virtues were ascribed to it as well as mysterious powers of preserving the wearer from danger, protecting from the evil eye and so on. The coral is found in shallow water off the Algerian and Tunisian coasts as well as those of some parts of Italy and of various Mediterranean islands. The Algerian reefs are divided into ten regions, of which only one is "fished" each year, so that ten years may be allowed for the renewal of the crop. The collection of the coral and its manufacture are now mainly in Italian hands. Coral of the very finest colour may be worth as much as £100 per ounce, but, of course, such a price is exceptional. There is a steady demand for it from China, India, Central Asia, etc., the European market varies according to the incalculable caprices of fashion.

The most highly valued of all forms of calcium carbonate is the Pearl. This is found, as we all know, within the shell of the pearl-oyster. The best are those perfectly spherical ones which are loose in the soft tissues of the mollusc, those which are attached to the interior of the shell are less symmetrical and usually less valuable. According to Professor Cunningham the cause of pearl-formation in most, if not all, cases is the dead body of a minute parasite, so that it has been said that "the ornament that has in

all ages been associated with beauty and riches is nothing but the brilliant sarcophagus of a worm." From the shells of the pearl-oyster comes the substance known as mother of pearl. The north and north-west of Australia and the Straits Settlements are among the localities from which European supplies come. The annual value of that imported into England amounts to £300,000 or so, and many persons find employment in working in this material. It is used for inlaid-work of various kinds, for cutlery handles, buttons and many other such purposes.

Thus far we have been dealing with the uses of various forms of Calcium Carbonate dependent upon physical and mechanical properties. Thus the hardness of marble is neither too great nor too small for the purposes of the sculptor, purposes for which its evenness of texture and capability of taking a high polish further adapt it. The softness and whiteness of chalk are the properties upon which most of the uses already mentioned depend. Bath-stone and other calcareous building-stones are easily quarried and worked into shape and harden by exposure, coral and pearl are fitted by colour in the one case and iridescent lustre in the other for purposes of personal adornment. But there are equally numerous uses dependent upon chemical properties. When any form of Calcium Carbonate is heated to a sufficiently high temperature it is split up into two substances. One of these is lime, a white or whitish solid, the other an invisible gas, carbon dioxide. In the first lecture of the course the process of lime-burning and the use of lime in making mortar were described. Reference was also made to hydraulic mortars and to cements. There is a kind of loosely coherent volcanic sand found at Pozzuoli, near Naples, which gives a good hydraulic mortar when mixed with ordinary lime. Roman cement is made from a peculiar kind of impure limestone containing a certain proportion of clay and known as cement-stone. This is burnt in kilns, then ground, sifted and mixed with sand. Portland cement is made from chalk mixed with the clayey mud of the Thames and Medway. These are ground with water to a creamy consistence and the cream allowed to stand for a few weeks in reservoirs. The excess of water is drawn off and the mixture dried, burnt in kilns and finally ground to powder. This is the wet process, but this cement is also made by a dry process from other kinds of limestone than chalk and other kinds of clay. The cement is generally mixed with sand and gravel or broken stones. It has great strength, whilst its power of hardening under water renders it useful for dock work, breakwaters and the like.

A mass of stones, sand, gravel, etc., held together with cement or ordinary mortar is known as concrete.

The use of lime in building is immense. Limestone from the quarries is used in certain districts for building purposes and the finer varieties are carried to distant places for facing or otherwise ornamenting houses and other buildings constructed in the main of other materials. Only a few persons, except in Dreamland,

dwell in marble halls, but whether we live in palaces or small suburban villas, in baronial castles or thatched cottages, whether the walls are of brick or of stone, mortar made with lime is practically universal. Important as is this use of lime it is not the only one, and we now go on to mention a few of the others. As I have already said, lime properly so called, i.e., the oxide of the metal calcium, is very infusible. Heated to a very high temperature by a flame of hydrogen or coal gas fed with oxygen, lime glows with a pure white light. This is the lime-light that Mr. Thomas, the Society's lanternist, manipulates so well. As lime is infusible at the temperature of the oxy-hydrogen flame, platinum can be melted in a cavity excavated in a block of it. A couple of pounds was melted in this way as far back as 1847, and since then the methods have been improved and much larger amounts can now be dealt with. In the electric furnace even higher temperatures can be obtained than in the oxy-hydrogen one. Here, again, the infusibility of quick-lime has rendered it of the greatest service.

Carbon dioxide gas, which is given off from chalk when strongly heated, can also be obtained by treating the chalk with an acid. It is in this way that most of the gas used by the manufacturers of soda water, lemonade, and other effervescing drinks is obtained. Such beverages are often called mineral waters and the mention of this name suggests another and most important use of lime, namely, the softening of naturally hard water. Although I gave some account of this in my earlier lecture I can hardly pass it over without further reference now. As I have already said so many times that you will be weary of hearing it, limestone and chalk are chemically identical substances composed of lime and carbonic acid, or, more strictly, carbon dioxide. Now lime as such is soluble in water. One equivalent of lime combined with one equivalent of carbonic acid is the insoluble carbonate, but one equivalent of lime with two equivalents of the acid is the soluble bicarbonate. Water from springs and wells in chalk or limestone contains this bicarbonate in greater or less amount. When much is present the water is unpleasantly hard, tends to waste of soap, and is in various other ways objectionable. In order to soften it the proportion between the equivalents of lime and carbonic acid must be altered from 1:2, giving the soluble bicarbonate, to 1:1, giving the insoluble carbonate. The necessary alteration in the proportions can be brought about either by reducing the amount of carbonic acid or by increasing the amount of lime. When the hard water we are speaking of is boiled it is softened in the former of these ways. Carbonic acid is expelled as gas and the resulting carbonate separates as a crust or fur on the bottom or sides of the vessel. Such a plan for softening water is admirable for a pint or two or even a few gallons, but is obviously impossible to apply to the water supply of a town. In such a case we can fall back upon our second method. Instead of bringing the proportion between the equivalents of lime and carbonic acid from 1:2 to the desired value of 1:1 by decreasing

the second member of the ratio we can achieve our object by increasing the first member, i.e., by adding to the water an appropriate amount of lime. This combines with the second equivalent of carbonic acid and thus becomes insoluble. The removal of the extra dose of carbonic acid causes the carbonate of calcium originally in solution to become insoluble also so that it separates out as well. After due settling and straining the water is softened and fit for use. Thus one compound of calcium is used as a remedy for a defect in the water due to the presence of another compound.

Let us think again of a bottle of soda water. The liquid it contains consists of water charged with carbonic acid gas and containing a small quantity of bicarbonate of soda. The water was, very likely, softened by the lime process. The carbonic acid was probably got by acting on chalk with acid. The third constituent, bicarbonate of soda, although it contains no calcium, was certainly made by a process in one or more stages of which calcium carbonate played an important part. The alkali manufacture is one of the very largest and most important of the world's chemical industries. It may be taken to include the production of carbonate and bicarbonate of soda and of caustic soda. In 1900 the total production of these substances had reached the imposing figure of one and a half millions of tons and since then it has no doubt largely increased. To describe the various processes employed would be straying beyond the legitimate limits of the present lecture, but I may say that chalk or limestone is used in them all. Roughly, each pound of soda turned out requires a pound of limestone to be used in the manufacture. Thus some two million tons of calcium carbonate are used annually in the alkali manufacture; an impressive example of the application of the lime compounds in the service of man.

We have seen that all the contents of the soda-water bottle had some bearing on our subject and this is quite as much, or more, the case with the bottle itself. In the concluding lecture of the "Silica Series" I dealt with the manufacture of glass so that I need only now remind you that ordinary bottle glass contains something like 20 per cent. of lime. Another industry in which enormous quantities of limestone are required is that of iron smelting. The most important of our English ores of iron contains much clay. This clay is practically infusible and the iron could not be readily, if at all, separated from it were it not for the intervention of limestone. At the high temperature of the blast furnace limestone and clay act on each other and an easily fusible slag is formed. About half a ton of limestone is required for every ton of pig iron that is produced. As a single large modern furnace may produce 70,000 tons of iron per annum we can form a rough estimate of the immense quantity of limestone used for this purpose alone.

Another large-scale use of lime is in the manufacture of bleaching powder, perhaps better known as Chloride of Lime. This substance, through its properties as a disinfectant, tends to

lengthen the life of man, while, when used as a bleaching agent in the laundry, it shortens the life of his collars and shirts. Amongst its uses may be mentioned the bleaching of cotton, linen and paper-pulp. This compound is one of those I had in mind when, at the beginning of the lecture, I said that in some of the compounds of calcium used in the arts and industries the calcium is only a junior partner. I mean that in the industrial uses of chloride of lime the valuable properties are due to the chlorine rather than to the lime. The function of the latter is to reduce the chlorine to a convenient and manageable form. There are many cases in which lime or chalk is used in preparing some substance which, in its finished state, contains no calcium. Such uses of lime are, however, very important, as it would not be possible to find any other substance which could conveniently be substituted. Take, for instance, the well known vegetable acids, citric, tartaric and oxalic. The first of these is made from the juice of the lemon and the lime fruit. The name of the latter, by the way, is only by accident spelt and pronounced like that of calcium oxide. Lime, as the name of a fruit, may be regarded as a variant of the word lemon, both being derived from the same Persian word. Lime, as the name of the base of chalk, is of quite different origin and is related to our own word "slime." Its primary application seems to be to things that are sticky or pasty, and it was probably given to the substance now called lime because of its use in making the mortar which serves to stick together bricks, stones and other building materials. To return to citric acid. The juice of the fruit is boiled and filtered and powdered chalk added to the still boiling liquid. Insoluble calcium citrate is formed and from this free citric acid can easily be obtained. Tartaric acid is made by a somewhat similar process from the crude cream of tartar that is deposited from grape juice during its conversion into wine by fermentation. In this case, however, another calcium compound is used in addition to chalk. This other compound, calcium chloride, is quite different from "chloride of lime" as bleaching powder is sometimes called.

The frequent occurrence in plants of calcium oxalate was mentioned by our President in an earlier lecture of the course, but these natural oxalates are not used as a source of oxalic acid on the commercial scale. When sawdust is made into a paste with a strong solution of potash and soda and then baked a large yield of the oxalates of these alkalis results. These salts are converted into calcium oxalate by boiling with lime and water and the free oxalic acid can then easily be obtained.

One other use of lime in connection with vegetable acids may be quoted here. At one stage of the preparation of acetic acid the crude liquid obtained by distilling wood is neutralised with lime.

In some cases lime is used in quickening up the pace of some chemical action which it is desired to bring about. Thus, by adding a little lime to animal fats, such as tallow or the refuse fat from butchers' shops, and then treating the fats with steam under

considerable pressure and, therefore, at a temperature higher than that of steam from a kettle, the chemical action known as hydrolysis is brought about. The fats are decomposed and yield a mixture of "fatty acids" and a watery solution of glycerine. From the former the liquid portions are squeezed out and the remaining solid ones, melting at considerably higher temperatures than the original tallow, are used for the manufacture of candles. From the watery solution the glycerine is, by suitable means, extracted, and serves as the starting point in the manufacture of such explosives as nitro-glycerine and dynamite. The mention of these words recalls that overwhelming subject of the war which we cannot long exclude from our thoughts. Even in the comparatively perfect security of Bournemouth we experience, in the darkened state of our streets, one of the minor consequences of the war. Many gas-lamps remain unlighted. In this sentence we have a text for the next division of our subject, the use of lime in the coal gas industry. The crude coal gas, after coming from the retorts and bubbling through water in a great pipe, called the hydraulic main, contains many impurities. These give it a peculiarly foul smell, and, if not removed, would yield products of combustion most injurious to health. Lime is one of the substances used to effect purification in some, although not in all, gas works. For this purpose the lime, prepared as usual by heating limestone or chalk, is carefully slaked and, when quite cold, placed in a special apparatus known as a "lime purifier." The crude gas is passed through the purifier so as to bring it into intimate contact with the lime, which retains the sulphuretted hydrogen and other objectionable impurities. In the hydraulic main, already referred to, two layers of liquid are found. The lower is crude coal-tar, the upper and watery one contains various compounds of ammonia, and is known as ammonia liquor. To obtain free ammonia from this the liquor is heated with lime. The lime retains the various acids with which the ammonia was associated, and the ammonia itself passes on to another part of the apparatus where it is absorbed by sulphuric acid. It is in this way that the sulphate of ammonia is made which some of you probably use for your lawns and other purposes in the garden. The value of sulphate of ammonia in horticulture and agriculture is mainly due to the combined nitrogen which it contains. In recent years several methods have been applied to solve the problem as to how the illimitable store of free nitrogen existing in the air may be drawn upon so as to render it available for agricultural and other purposes. To give even a brief account of these would require a separate lecture; I shall now simply mention them in so far as is necessary to show how use is made of lime in this department of chemical industry. By passing air through an enormous electric arc a small fraction of the nitrogen and oxygen are induced to combine and ultimately to yield nitric acid. Much of the acid thus made is neutralised with lime and so converted into calcium nitrate. This product is known by various names such as air

saltpetre and Norwegian saltpetre. It is used as a manure and for making other nitrates and derivatives of nitric acid. Nitrolim or calcium cyanamide is another calcium compound containing nitrogen of atmospheric origin. When lime is heated with coke or charcoal, both the elements of the lime unite with the carbon. The oxygen forms a gaseous substance, the calcium a solid compound known as calcium carbide. This substance is familiar to most of us, as its use in preparing acetylene gas is well known. Besides its use for this purpose it is employed in making the nitrolim to which I referred just now. Atmospheric nitrogen is passed over the calcium carbide at a very high temperature, and nitrolim results. Its chief use is as manure. Under the influence of moisture and carbonic acid it undergoes a complex decomposition in which, no doubt, bacteria play an important part. Various intermediate substances are formed, and finally the nitrogen is brought into a form suitable for use by plants.

Another calcium compound valuable for manurial purposes is that known as superphosphate of lime. It is made by acting with sulphuric acid on bone-ash or on one of the various minerals which, like bone-ash, consist mainly of calcium phosphate. Over 700,000 tons are manufactured annually in Great Britain. Bone-ash and the mineral phosphates just mentioned are the source of the phosphorus used in making matches. It is the presence of that element that gives them their chief value, still, as they are calcium compounds I thought it not unfair to mention them.

We have not, however, by any means exhausted the inventory of the uses of lime itself. It has, for instance, an important part to play in the sugar industry. Milk of lime, i.e., the milky-looking liquid obtained by stirring together slaked lime and water, is added to the expressed juice of the sugar cane to neutralise the acids present and to aid in the removal of certain other impurities which, if allowed to remain, would lower the quality of the sugar. In the case of beet-root sugar, the use of lime is not less essential. The solution obtained by steeping the pulped beets in water or by some alternative method, is treated with milk of lime to get rid of acids and salts. The excess of lime is removed by a current of carbonic acid gas, and the juice, freed from many of its original impurities, is often subjected to a repetition of the treatment, but this time at the boiling point, to complete the removal of the objectionable constituents.

There is no obvious connection between the lump of sugar which a man adds to his breakfast coffee and the boots which, when breakfast is over, he puts on to go to his office or for his morning walk, yet a link may be found between them in lime. Before hides or skins can be tanned they must be cleaned and prepared, hair or wool must be removed, and so on. Lime water or milk of lime is used for these purposes. The hides are steeped in lime pits until the hair can easily be removed by scraping. The lime having thus played its part must not be allowed to remain on or in the hide. The removal is brought about by soaking in

an acid liquid in the first tan pit, or by a preliminary treatment called "bating," before putting the hides into the pit. With the exception of the phosphate and superphosphate of lime which it seemed appropriate to mention in connection with other calcium compounds used as fertilisers, we have confined our attention hitherto to calcium carbonate and substances such as quick lime, slaked lime, calcium carbide, etc., which are made directly or indirectly from the carbonate. There is, however, another natural calcium compound occurring in very large quantities that up to the present has only just been mentioned. It is now time to turn our attention to calcium sulphate. Like the carbonate, it is found in various forms, having special names and used for different purposes. When massive and compact so as to resemble marble in appearance it is called alabaster. This is sometimes white and translucent, sometimes veined and is used for ornamental purposes and for statuettes, vases, candlesticks and the like. As it is somewhat soluble in water it is not suited for use in ornamenting the exterior of a building, where it would be subjected to the solvent action of rain, but it can be effectively used for interior decoration. The alabaster box of precious ointment of which we read in the New Testament was probably not made of the material now called alabaster, but of a special kind of marble, to which the name was formerly applied. In a lecture given on April 20th by Mr. Weigall, formerly Inspector-General of Antiquities to the Egyptian Government, the lecturer described an alabaster jar discovered in a Royal Tomb which still contained the liquid put into it 3,500 years ago. The report of the lecture does not say in what sense the word alabaster is here used, but probably the jar was of the stalactitic marble just mentioned and not of alabaster in the modern sense. The more commonly occurring varieties of native calcium sulphate are known as "gypsum" and are much used in making Plaster of Paris. This is most useful to the sculptor, the architect, the potter and the surgeon, and for making casts of miscellaneous small articles such as coins and medals, so that it occupies a high place among the calcium compounds used in the service of man. Artificially prepared calcium sulphate, bearing much the same relation to gypsum, that the precipitated chalk used in tooth-powders bears to native chalk, is employed in the preparation of some kinds of paper under the name of pearl-hardening. Fluor spar is another calcium compound occurring as a mineral. Some specimens are colourless and transparent, others beautifully tinted blue, green, yellow, red, etc. Several colours may occur in different parts of the same specimen. It is not hard enough to take rank as a gem, but is used for making vases and ornaments of various kinds. As it is found in some abundance in Derbyshire it is often known as Derbyshire Spar. Cornwall also furnishes the mineral, and it is there used as a flux in the treatment of copper ores. From it is prepared hydrofluoric acid, distinguished amongst other acids by the unusual property

of attacking glass, so that fluor-spar is used in making a kind of ink for writing on glass. By dissolving chalk or marble in hydrochloric acid and evaporating the solution we obtain calcium chloride, a substance not to be confounded, as I have already said, with chloride of lime. To the chemist, at any rate, this substance is of great use on account of its great attraction for water. This property renders it suitable for drying gases and removing moisture from the many organic chemicals which have hitherto been made mainly or exclusively in Germany, but which we hope will in future be produced at home. The crystallised chloride, mixed with snow, forms an excellent freezing mixture, having a much lower temperature than is reached by a mixture of salt and snow. By mixing a solution of it with a solution of carbonate of soda we get the precipitated chalk, to which reference has already been made. In the first lecture of the series I spoke of calcium sulphide as being used in making luminous paint, match-boxes and the like.

I have now mentioned about thirty-three uses or sets of uses of lime and its derivatives. There are doubtless many others which I have not thought of, and probably still more of which I have never heard. Still I think that those I have described are quite enough to justify the claim of calcium to rank among those chemical elements whose compounds have a wide and varied field of usefulness.

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